JUNE 1954

Journal

VOL. 46 • NO. 6

AMERICAN WATER WORKS ASSOCIATION

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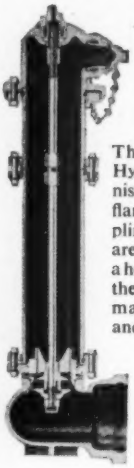

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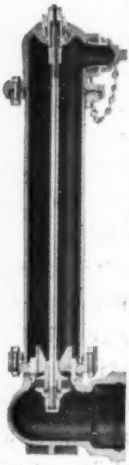

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Journal

AMERICAN WATER WORKS ASSOCIATION

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June 1954

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AWWA ANNUAL CONFERENCE

Chicago, Ill. June 12-17, 1955

AWWA SECTIONS

May 25—Pacific Northwest Section luncheon meeting at Norselander Cafe, Seattle, Wash. (Business meeting only; to be held during AWWA Conference May 23–28.)

Jun. 22—New Jersey Section Summer Outing (inspection trip and luncheon) at Boonton. Secretary, C. B. Tygert, Box 178, Newark 1, N.J.

Jun. 23–25—Pennsylvania Section at Americus Hotel, Allentown. Secretary, L. S. Morgan, Div. Engr., State Dept. of Health, Greensburg, Pa.

Sept. 9–10—New York Section at Montauk Manor, Montauk, L.I. Secretary, Kimball Blanchard, Rm. 1922, 50 W. 50th St., New York 20, N.Y.

Sept. 15–17—Michigan Section at Occidental Hotel, Muskegon. Secretary, T. L. Vander Velde, Chief, Secretary of Water Supply, State Dept. of Health, Lansing 4, Mich.

Sept. 20–22—Kentucky-Tennessee Section at Andrew Jackson Hotel, Nashville, Tenn. Secretary, J. Wiley Finney Jr., Asst. Director, Div. of San. Eng., State Dept. of Public Health, 420—6th Ave., N., Nashville 3, Tenn.

Sept. 22–24—Ohio Section at Biltmore Hotel, Dayton. Secretary, M. E. Druley, Manager, Dayton Power & Light Co., Wilmington, Ohio.

Sept. 26–28—Missouri Section at Hotel Governor, Jefferson City. Secretary, Warren A. Kramer, Div. of Health, State Office Bldg., Jefferson City, Mo.

Sept. 28–30—Wisconsin Section at Hotel Northland, Green Bay. Secretary, Leon A. Smith, Supt. Water & Sewerage, City Hall, Madison 3, Wis.

Oct. 6–8—Minnesota Section at Lowry Hotel, St. Paul. Secretary, Leonard N. Thompson, Gen. Mgr., Water Dept., St. Paul 2, Minn.

(Continued on page 8)

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Coming Meetings

(Continued from page 6)

Oct. 13–15—Iowa Section at Hotel Roosevelt, Cedar Rapids. Secretary, H. V. Pedersen, Supt. of Water Works, Municipal Bldg., Marshalltown, Iowa.

Oct. 17–20—Southwest Section at Cortez Hotel, El Paso, Tex. Secretary, Leslie A. Jackson, Mgr.-Engr., Municipal Water Works, Robinson Memorial Auditorium, Little Rock, Ark.

Oct. 24–27—Alabama-Mississippi Section at Tutwiler Hotel, Birmingham, Ala. Secretary, Charles W. White, Asst. San. Engr., State Dept. of Public Health, 537 Dexter Ave., Montgomery 4, Ala.

Oct. 26–29—California Section at Wilton Hotel, Long Beach. Secretary, Henry Franklin Jerauld, Asst. Supt. of Constr. & Operation, Water Dept., 1040 Manzanita, Pasadena 3, Calif.

Oct. 27–29—Chesapeake Section at Belvedere Sheraton Hotel, Baltimore, Md. Secretary, Carl J. Lauter, 6955 —33rd St., Washington 15, D.C.

Nov. 3–5—Virginia Section at Jefferson Hotel, Richmond. Secretary, J. P. Kavanagh, 213 Carlton Terrace Bldg., Roanoke 11, Va.

Nov. 4–6—New Jersey Section at Madison Hotel, Atlantic City. Secretary, C. B. Tygert, Wallace & Tiernan, Inc., Box 178, Newark 1, N.J.

Nov. 7–10—Florida Section at Soreno Hotel, St. Petersburg. Secretary, Harvey T. Skaggs, Secy. & Gen. Mgr., Amica-Burnett Chemical Co., Box 2328, Jacksonville, Fla.

Nov. 8–9—West Virginia Section at Prichard Hotel, Huntington. Secretary, H. K. Gidley, Director, Div. of San. Eng., State Dept. of Health, Charleston 5, W.Va.

Nov. 8–10—North Carolina Section at George Vanderbilt Hotel, Asheville. Secretary, E. C. Hubbard, Exec. Secy., State Stream Sanitation Com., Box 2091, Raleigh, N.C.

Nov. 9–10—Rocky Mountain Section at Broadmoor Hotel, Colorado Springs, Colo. Secretary, George J. Turre, San. Engr., Board of Water Comrs., Box 600, Denver, Colo.

Dec. 2–4—Cuban Section at Sociedad Cubana de Ingenieros, Havana. Secretary, Laurence H. Daniel, Pres., Laurence H. Daniel, Inc., Baratillo 9, Havana, Cuba.

OTHER ORGANIZATIONS

Jun. 13–18—American Society for Testing Materials, in Chicago

Jul. 25–31—Inter-American Conference of Sanitary Engineering, in Sao Paulo, Brazil.

Aug. 3–13—Pan-American Federation of Engineering Associations (UPADI) at Sao Paulo, Brazil

Oct. 4–6—New England Water Works Assn., Poland Springs, Me.

Oct. 11–14—Federation of Sewage & Industrial Wastes Assn., in Cincinnati.

Oct. 11–15—American Public Health Assn., in Buffalo

Oct. 17–20—American Society of Civil Engineers, in New York City

Oct. 19–20—Public Utilities Sessions, National Safety Congress, Chicago

Oct. 19–22—Pennsylvania Water Works Assn., in Atlantic City, N.J.

Nov. 17–19—Water Works Management Short Course, at Univ. of Illinois, Allerton Park, Ill.

Nov. 28–Dec. 3—American Society of Mechanical Engineers, in New York

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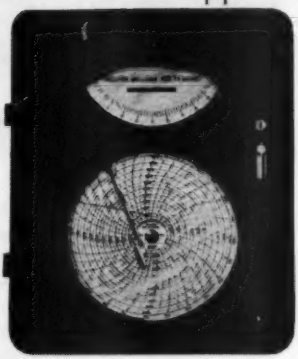

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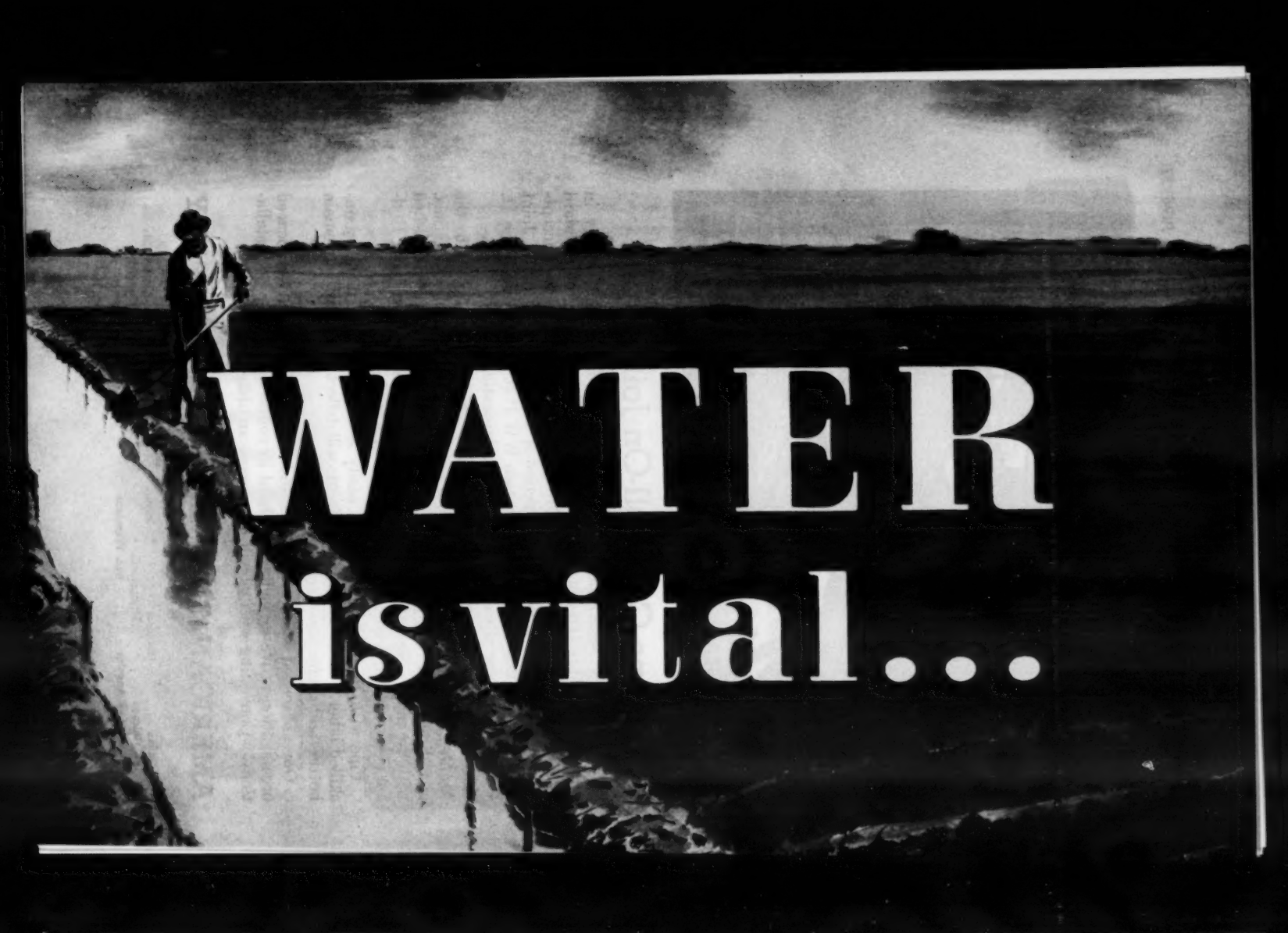
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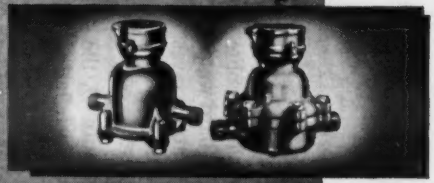

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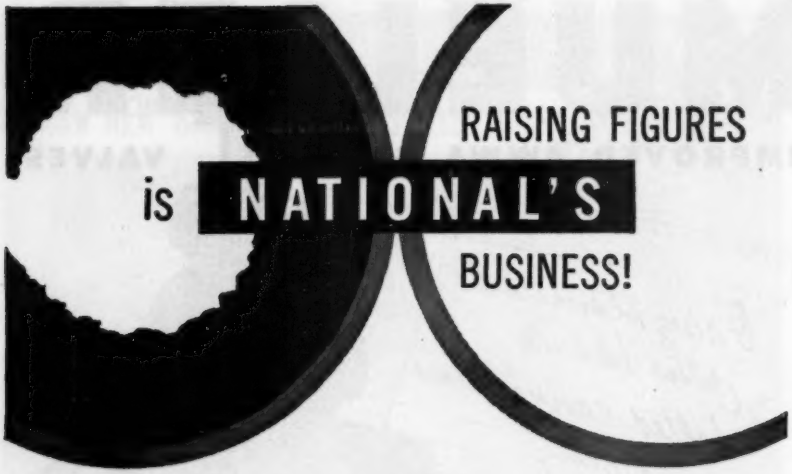

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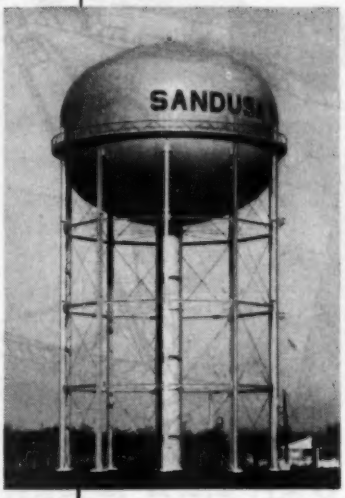

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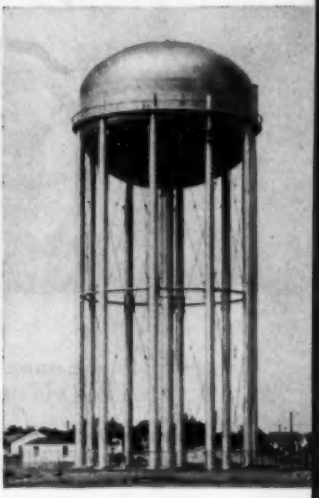

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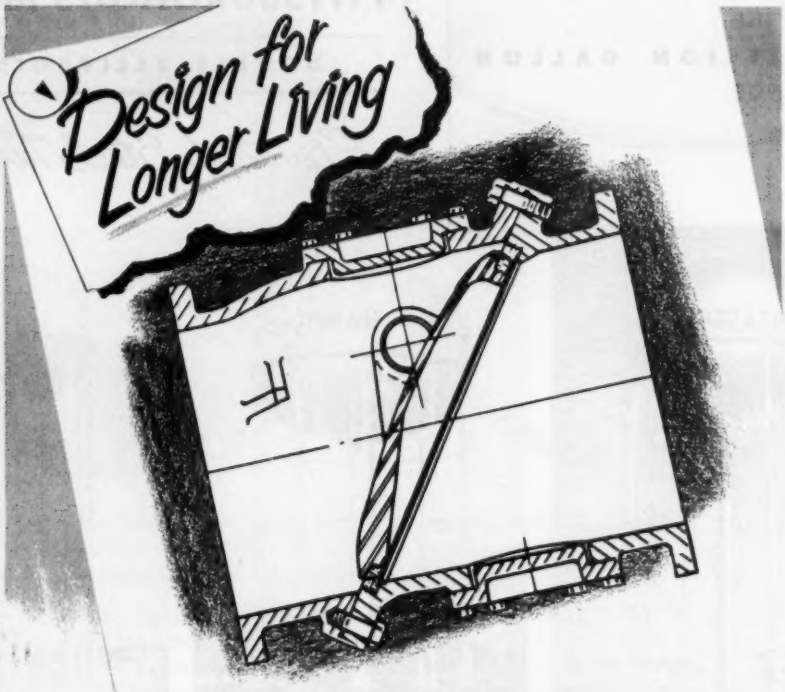

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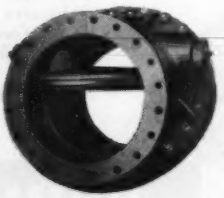

And this balancing is the reason why Chapman Tilting Disc Check Valves greatly reduce head loss over standard designs of swing-type checks . . . as proven by tests in leading engineering schools and by actual performance in the field. Available in iron or steel. Complete test data is given in Catalog No. 30—write for your copy now.

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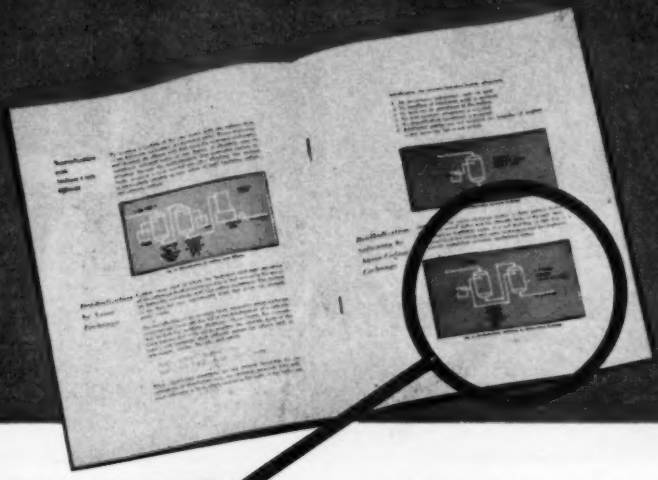

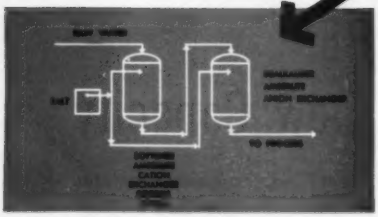

Fig. 6—Dealkalization-Softening by Anion-Cation Exchange

A strongly basic AMBERLITE anion exchange resin permits control of alkalinity of water supplies for boilers and cooling systems conveniently and at low cost. Only common salt is required as regenerant for the resin. No acids are used, hence expensive acid-resistant equipment and associated handling problems are eliminated. Because no degasifier is required, line pressure is not broken, and pumping costs are reduced.

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Rohm & Haas Company's new book, *If You Use Water*, discusses this up-to-date technique—and many other ion exchange methods of water treatment as well. Softening, combination softening-dealkalization, silica removal, deionization, are just some of the topics considered. Your request for this book will bring you a copy promptly, will show you why in ion exchange the resin that's *right* is AMBERLITE.

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Write us for complete data. Armco Drainage & Metal Products, Inc., Welded Pipe Sales Division, 3664 Curtis Street, Middletown, Ohio. Subsidiary of Armco Steel Corporation. In Canada: write Guelph, Ontario.

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The test of a century

F.P.G.

This is Lancaster, Pa., County seat in one of the most highly cultivated farming districts in America.

Bettmann Archive

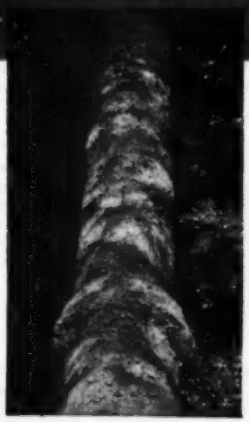
Old print showing southwest view of Lancaster about 100 years ago.

MODERNIZED cast iron

is the test that tells!

LANCASTER installed cast iron water mains 100 years ago . . . and installs them today.

Lancaster, Pa., has grown in 100 years from about 12,000 population to nearly 65,000 — but it has not outgrown the habit of buying cast iron pipe. From four miles of water mains a century ago, the present distribution system has increased to 105 miles of pipe—all of it cast iron pipe. Services have grown from 2,000 to nearly 20,000.



This cast iron water main laid in 1835 by the Bureau of Water of Lancaster is still functioning after 119 years of service.

The word "test" means—"*put to the proof*"—according to the dictionary. Well, 60 utilities have put cast iron pipe to the *proof* for a century—a test to end all tests. They installed cast iron water or gas mains 100 years, or more, ago that are still in service. Yes, the test of a century has *proved* beyond question the long life and low cost per service year of cast iron pipe.

Cast iron pipe has been a rugged, long-lived product from the earliest days. Today's *modernized* cast iron pipe, centrifugally cast, is even stronger, tougher, and more uniform in quality. And, where needed and specified, it is centrifugally lined with cement mortar to assure sustained carrying capacity throughout the long life of the pipe.

Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3.

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how much does it cost to run the old model?

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As a top municipal official, as an ethical consultant, as a practical operating man—you must admit if all these things we say are true, you can't afford to ignore this new chlorinator.

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complete process instrumentation

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you can use **smaller** pumps

...when you protect pipe lines with BITUMASTIC® 70-B ENAMEL

PIPE LINES don't "shrink" when interior surfaces are lined with Bitumastic 70-B Enamel . . . because this durable enamel prevents rust, corrosion, incrustation and tuberculation. With an inside diameter that *stays* the same, line capacity doesn't decrease. So there's no need, even after decades of service, to replace pumps with bigger ones that cost more to buy and operate.

By using Bitumastic 70-B Enamel, you also save on the initial cost of steel pipe. You don't waste money by buying *over-sized* pipe in order to allow for future "shrinkage." You specify pipe solely on the basis of desired capacity.

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Practical water or gas distribution men well know that pipe line settlement, expansion and contraction from season to season sometimes cause joint leaks in bell-and-spigot pipe lines.

This kind of trouble may be prevented in future pipe line construction by the use of McWane-Pacific Boltite mechanical joint cast iron pipe. Boltite mechanical joints stay flexible; permit settlement, expansion or contraction without leakage. The special bolts, glands, and sealed-in rubber compound gasket last as long as the pipe.

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The Miss at this fountain of youth would be mighty disappointed if low water pressure were suddenly to deprive her of a drink—and so would millions of others who take water pressure for granted. One of the best, and least expensive ways to assure the constant flow of water is through Centrilining.

The Centriline process thoroughly cleans and centrifugally applies cement-mortar to the interior of pipe lines in place—prevents corrosion, tuberculation and leakage; minimizes interruption of line operation and street traffic. For an effective, economical means of increasing flow capacity, look to Centriline.

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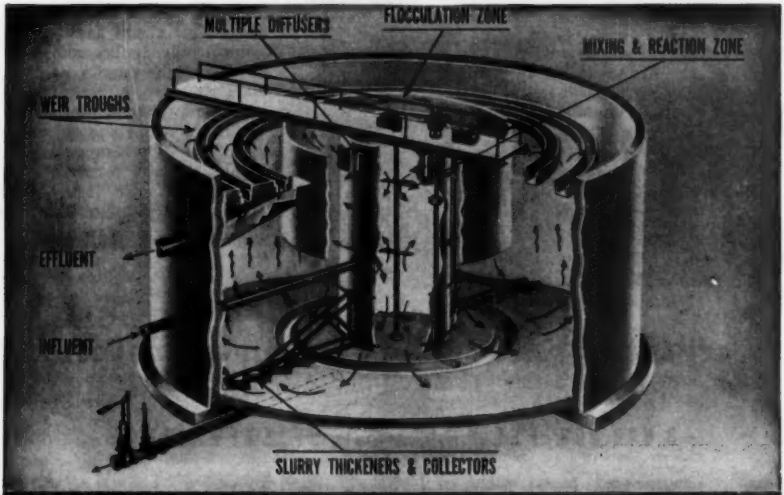

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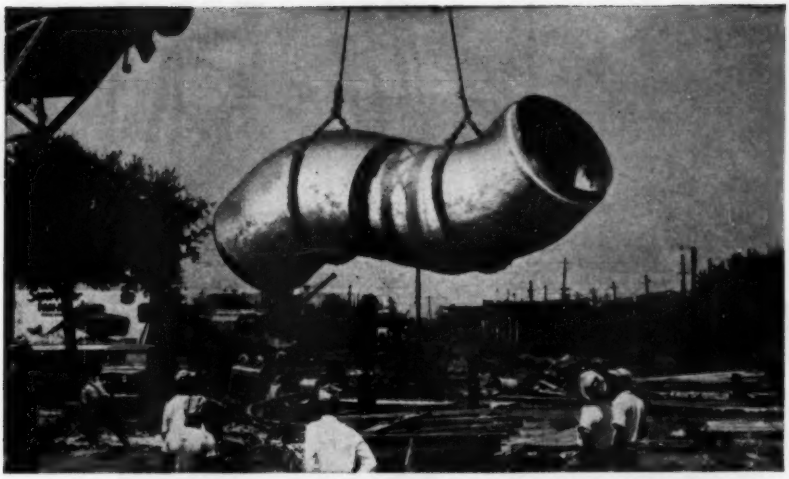


Special curved section of 50-in. ID Bethlehem Pipe being lowered into trench in New Orleans.

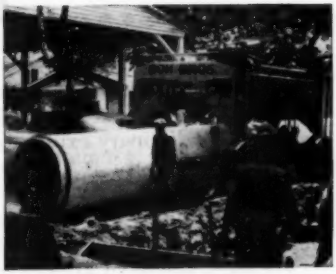
New Orleans Modernizes Water System with 95,000 Feet of Bethlehem Steel Pipe

To meet greatly increased demands caused by the city's tremendous postwar growth, the Water and Sewerage Board of New Orleans has installed almost 18 miles of large-diameter water and sewage lines.

Today, New Orleans boasts nearly 60,000 feet of new 50-in. ID water mains, as well as 35,000 feet of sewage lines in diameters ranging from 24 in. to 50 in. ID. All of this pipe, together with a variety of T's, bends, reducers and flanges, was supplied by Bethlehem.

You'll find Bethlehem Tar-Enameled Pipe ideal for your water and sewage lines. It has great strength, shock-resistance and resilience. And its smooth, uniform lining of coal-tar enamel resists corrosion and incrustation, ensures a high rate of flow year after year. It is furnished in easily-handled 40-ft lengths, and in all diameters from 22 in. ID to the largest permitted by common carriers.

We suggest that you phone or write the nearest Bethlehem sales office for complete information about Bethlehem Tar-Enameled Steel Pipe.



Laying straight section of 50-in. ID pipe. Engineers on the job found the Bethlehem Pipe easy to cut and re-weld when obstructions were encountered.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

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Layne's service is complete from exploration to the finished installation and is offered without divided responsibility. That is one reason why so many of the leading industries and larger municipalities have entrusted ground water development to this organization. But that service is just as important—and available—to the smaller farmer, industry or city.

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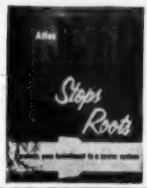
Operating costs go down. By reducing infiltration of soil water, JC-60 sewer joints reduce pumping costs and equipment capacity required at the disposal plant.

Installation costs go down. JC-60, with minimum shrinkage, high fluidity and resistance to overheating deterioration speeds the entire jointing procedure and minimizes material waste.

Years of ATLAS research created this remarkable new jointing compound. Based on a synthetic plastic, JC-60 is designed specifically to provide those characteristics proved most desirable in actual use.

COMPLETE FACTS are in Bulletin M20-3 and other technical literature. *Write for your copies.*



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Maximum corrosion resistance without sacrifice of structural design.

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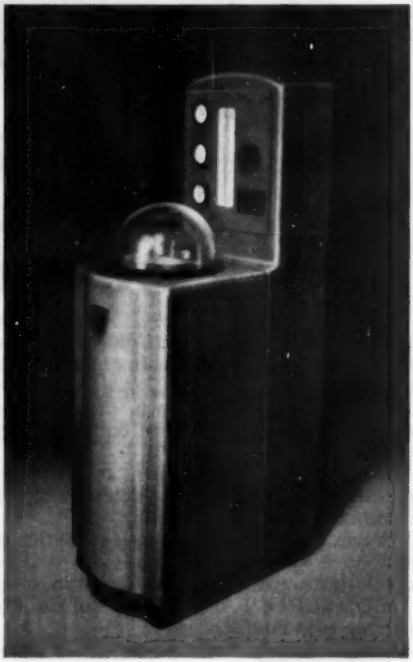
May be operated by manual control, or automatically by electric, hydraulic, air pressure or air vacuum control.

Feed rates up to 1000 pounds per 24 hours.



For the best in equipment, look for the PLUS VALUES that add up to Dependable Chlorination.

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Journal
AMERICAN WATER WORKS ASSOCIATION
VOL. 46 • JUNE 1954 • NO. 6

Progress Toward an Industrywide Safety Program

By Raymond J. Faust

A paper presented on May 5, 1954, at the President's Conference on Occupational Safety, Washington, D.C., by Raymond J. Faust, Exec. Asst. Secy., American Water Works Assn., New York.

IN 1951 an AWWA task group (*1*) reporting its findings on safety practices in the water industry concluded that:

1. With some notable exceptions, the water works industry is not safety conscious.

2. The frequency rate of disabling injuries in water utilities in 1949, as reported by the National Safety Council, was 33. This figure compares rather unfavorably with the other utilities: gas 17; electrical, 14; and communciations, 2.

3. The accident severity rate for the water works industry for 1949 . . . was approximately equal to the national average for all industries.

It must be understood that the water industry figures were based on conditions in only 33 utilities, less than 0.2 per cent of the total of 17,000 operating units involved. Although the figures represent only a minute segment of the water industry, they depict the situation at its best, for it may be presumed that the experience in water works not even safety conscious enough to keep records was worse than in the few utilities with established programs.

The task group report also indicated that the lack of a safety program was not confined to small utilities. For example, a questionnaire survey of 153 towns showed that 5 of 14 water utilities serving more than 500,000 people reported having no safety program in 1951; the same was true of 27 of 49 utilities in the 100,000–500,000 group, 42 of 69 in the 30,000–100,000 group, and 15 of 21 in the 10,000–30,000 group. This analysis gives a representative view of the extent of safety practice in the industry in 1951, with one major exception: the questionnaire did not include the water utilities serving a population of less than 10,000, which comprise the great majority of plants. It is known, however, that the practice of safety in these small plants

is virtually nonexistent. Thus, it was apparent in 1951 that a real selling job was needed to establish an adequate safety program for the industry.

Obstacles to Program

A consideration of the size, organization, and financial aspects of the water industry may reveal why it has lagged behind other utilities in adopting a safety program. The number of water utilities in the United States is almost twice the total of gas, electric, and communications utilities combined. The promotional effort needed to establish a safety program at every water works is, therefore, very much greater than that required for other utilities.

Furthermore, 99.3 per cent of the 17,000 water utilities may be classified as small businesses, because they serve towns with less than 100,000 people and have an operating force of between one and 100 employees each. In fact, 93 per cent of the water utilities—that is, almost 16,000 units—may be classified as very small businesses, because they serve towns with less than 10,000 people and employ one to ten employees each. These figures become significant when it is realized that small businesses generally have been slow in adopting safety programs and that two-thirds of all industrial injuries occur in businesses with fewer than 100 workers. Thus, by itself, this great preponderance of small operating units largely explains the present position of safety in the industry. So-called big business in the industry comprises only 0.7 per cent of all water utilities; only 93 organizations employ 100 or more (up to 3,000) persons.

Another fact of importance is that 70 per cent of the water utilities, numbering approximately 12,000, are owned publicly and locally and operate without outside direction or help. In theory, each utility's administrative structure should include separate divisions for treatment, pumping, distribution, meters, transportation, commercial activities, engineering, management, and safety. In the vast majority of utilities, however, this number of divisions is greater than the number of employees. Obviously so elaborate an organizational setup is out of the question. In many small publicly owned water utilities, one man takes care of all divisions and, in addition, is chief of police and superintendent of streets, sewers, and parks, while, in his spare time, he acts as truant officer. It should be apparent that, in these circumstances, only what is immediately necessary will get done. Such refinements as safety are inherently abstract considerations, and a formal safety program has little chance of being established or maintained.

Finally, water utility personnel generally are underpaid. The result is that the industry fares poorly in bidding for the more highly skilled and trained personnel. Under this added handicap, new ideas or programs are not readily assimilated into an already underdeveloped organizational structure.

Safety Campaign

Despite these difficulties, the safety problem is being intensively attacked. In 1950, at the urging of Wendell R. LaDue, Chief Engr. and Supt., Bureau of Water and Sewerage, Akron, Ohio, and Chairman, AWWA Committee on Water Works Administration, the AWWA Board of Directors approved the appointment of a task group to

study and report on the status of safety in the industry. Published in 1951, the report (*1*) pointed out not only the need for the application of safety practices in the industry but also the advisability of a more detailed study. The latter was accomplished by setting up four task groups, assigned respectively to study safety as it applies to: [1] supply; [2] treatment and pumping; [3] distribution; and [4] administration. A report on these studies appeared in 1953 (*2*).

With interest in safety accelerating among AWWA members, the Board of Directors, in 1953, approved the preparation of a water works safety manual. The four task groups were united in this effort in a 16-man committee to do the job. The first rough draft of the text has already been prepared, and the document is scheduled for completion by the end of 1954. [When the manual becomes available, notice will, of course, appear in the JOURNAL.] The manual will be fully illustrated, with photographs and sketches covering almost every work assignment in the industry. It is expected that it will be especially helpful in promoting the adoption of safety programs in the small utilities, as well as in teaching the practice of safety.

Both the JOURNAL and *Willing Water* have carried many papers and stories on the practice of safety during the past three years. These articles tend to keep the subject before the utility operators and point out what can be and is being accomplished. An example of an excellent safety performance in the industry is the record made by the 232 employees of the Akron water utility in 1952. Only one lost-time accident was suffered in 447,095 hours of work. For this outstanding achievement, the National Safety Council presented Akron with an award of honor. A description of the Akron program has been published previously (*2*).

Another safety program which has met with considerable success is that of the Kansas City, Mo., Water Dept. (*3*). In August 1951 the department took its first step toward establishing such a program. Results were not long delayed. A check of the records showed that the cost of carelessness to the department was $4,360 for the period March–September 1952, compared with $16,473 for the same period in 1951. These costs include: wages paid to injured employees while they were not working because of their injuries; doctor and hospital bills; and settlement of claims for injuries and damage to property. In six months, $12,-113 was saved on these items, all of which are directly affected by a safety program. Success stories of this type are proof that an effective safety program is possible in the water industry. Many of the AWWA sections have established safety practice committees to study the problem regionally. The sections are also scheduling papers and panel discussions on safety at their annual meetings. Thus, the program is spreading to the local levels, where it can be sold most readily to the superintendents.

Conclusion

To date, the results of efforts to establish safety programs in the industry have been encouraging. The enthusiasm developed by many members of the industry has given the AWWA safety practice committee reason to believe that the program is gathering momentum. The job of winning over

the operators of small plants, however, is still to be done. To accomplish it, a strong and well directed educational campaign is necessary. Fortunately, the water industry has many short-course schools available to carry out this assignment. These schools were established years ago, principally by the state departments of health, to teach water plant operators the skills needed for the treatment and quality control of public water supplies. It took at least 40 years to disseminate the technical knowledge that has made waterborne diseases largely a thing of the past. The objective of a safe work environment at every water plant should not take nearly so long to achieve as did the objective of making all supplies bacteriologically safe. With the advantages of an established educational system, a strong national association, and the will to succeed in making the employees' environment as safe as the water they produce, the difficulties of realizing an industrywide safety program can and will be overcome.

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The New York State Thruway and Water Works Relocations

By Thomas M. Riddick

A paper presented on Apr. 23, 1954, at the New York Section Meeting, Watertown, N.Y., by Thomas M. Riddick, Cons. Engr., New York.

ACCORDING to a well worn cliche, there are three sides to every question: one's own side, the other fellow's side, and the right side. It is with full realization of the basic truth of this old bromide that the author sets forth in this paper some of the major differences of opinion which have arisen during his contacts with the New York State Thruway Authority. It seems desirable, at the outset, to present some of the factors that have undoubtedly been influential in the formation of the point of view of that agency.

The Thruway Authority was created by the state for the specific purpose of quickly constructing a badly needed superhighway from New York City to Buffalo. This is so stupendous an enterprise that it could hardly have been handled by an any single group of engineers. The authority appears, in many respects, to be an outgrowth of the State Dept. of Public Works, and it is often difficult to determine where one agency leaves off and the other begins. A total of 32 prime contractors and 33 firms of consulting engineers are involved in the work (*1*). The former are principally heavy constructors, and the latter are normally employed in the design of heavy construction projects. With one or two exceptions, these firms are not engaged in water works practice. This is as it should be, but it is reasonable to assume that engineering firms dealing with heavy construction are not too well prepared to cope with the minute details sometimes required for precise water works design.

The coordination of design by the engineering firms and the expediting of contract work totaling more than $500,000,000 comprise a gigantic undertaking. The project's scope alone seems an explanation for what often appears to be the complete neglect of consideration on the part of Thruway officials for the municipal water works involuntarily involved. Judging by the drive of the Thruway Authority to get things done, it would seem as if they had adapted the New York City Post Office slogan to read: "Neither snow, nor rain, nor heat, nor gloom of night, *nor municipal water works facilities,* stay these couriers from the swift completion of their appointed rounds."

There is another fundamental reason for the disparity in viewpoint between the water works engineer and the designer of highways and bridges. Although both are in the broad field of civil engineering, it is a fact, quite in accord with the dictates of human nature, that each individual tends to overemphasize the importance of his own field of endeavor and to minimize the

professional requirements of other branches of science, even though closely allied. It should not be too surprising, therefore, if highway and bridge engineers sometimes consider that laying large-diameter water pipelines under high pressure involves no more technical qualifications than, say, stringing out a few lengths of garden hose. And the author has no doubt that many competent water works engineers thoughtlessly regard the mere design of highways and bridges as strictly elementary in character.

Having thus outlined the other fellow's attitude as objectively as close proximity to the water works field permits, the author will now briefly examine some of the specific points of complete divergence of view between the Thruway Authority and water works engineers. Whether these differences amount only to a tempest in a teapot or are basic and fundamental may be left for others to appraise.

Oneida Pipeline Relocation

In the summer of 1952, the author was engaged by the Oneida, N.Y., Water Dept. to relocate approximately 1,200 ft of water transmission mains that interfered with the proposed Thruway installation. As the author had recently completed a comprehensive survey of the Oneida water works, he was familiar with its problems and was highly conscious of the inherent pipeline hazards involved. The transmission line in question is 20 in. in diameter and 20 miles in length; it has a static pressure of 250 psi at the point of the Thruway crossing and an operating pressure (dependent upon the rate of flow) of approximately 150 psi. The line is in almost continuous service, being shut down only for brief periods every few years in order to clean the main storage reservoir. The city relies solely on this line for water service, and, in addition, the line supplies a number of smaller towns in the vicinity, as well as one manufacturing plant using relatively large quantities of water and employing more than 4,000 persons.

There were two possible routes for relocating the line, both of which involved the following major crossings: Oneida Creek, approximately 70 ft in width; the proposed Creek Diversion Channel, which was to be installed by the Thruway with a width of 70 ft; and the two lanes of the Thruway proper. It was essential that the existing line remain in service until the installation of the new one was substantially completed, with an outage for final connections of not more than about a day. It was also necessary that the route of the line offer minimum obstruction to the roadway and bridge contractor, who at that time was moving on the job.

After much consideration of the many factors involved—particularly those of safety on the Thruway, continuity of water service, facility of pipe installation, ease of maintenance and repairs, and type of pipe and joint to employ—the southern route was selected (Fig. 1). The pipe material chosen for the first section of this line was Class 250 mechanical-joint, cement-mortar lined, 24-in. cast iron. The valved pipeline was to be extended under the Thruway in a 7¼-ft square concrete box culvert or conduit, 415 ft in length. The entrance end of the pipe tunnel had a rectangular pit of sufficient length to enable removal or installation of pipe sections. Both the

entrance section and conduit proper were to be equipped with an overhead I-beam for attaching a chain hoist trolley. The pipe was to be supported on and anchored to low concrete piers. The two 45-deg pipe bends required in this conduit necessitated very heavy anchorage, as thrust at these points amounted to 86,000 lb. The conduit was to have an earth cover of approximately 3 ft at the Thruway crossing, with an earth load of 20 ft at the (proposed) relocated county road, which was to be adjacent to the Thruway. Construction of the concrete pipe tunnel could have been undertaken immediately by the roadway contractor, so as to permit unobstructed movement of earthwork in this area. The downstream end of the conduit terminated with floor slab at grade, and a slight pitch allowed ready drainage of the entire tunnel.

At the point of emergence of the pipeline from the conduit, a change was to be made from cast-iron to steel pipe of $\frac{3}{8}$-in. wall thickness. As the low-lying meadowland in this area was difficult to excavate for pipe bury, the steel pipe was to be supported on low concrete piers set 50 ft apart, center to center. The existing and relocated brook channels were to be spanned, with piers located about midstream. To prevent corrosion, which could result in leakage, the steel pipeline was to be cement-mortar lined, in place, after construction. Connection was to be made with the existing 20-in. cast-iron line by means of flanged steel pipe. The thrust at this downturned elbow was approximately 150,000 lb, which necessitated a rather massive pier for anchoring the line in place.

The employment of a concrete pipe tunnel with an open end, which was

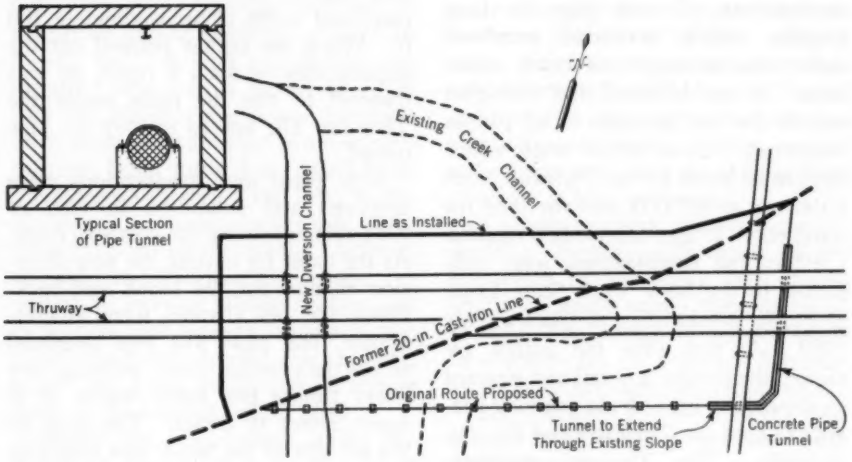

Fig. 1. Oneida Pipeline Relocation

The originally proposed route was rejected and the northern route adopted at the insistence of the Thruway officials.

possible under these terrain conditions, facilitated ready inspection of the line and easy maintenance. In the event of a serious break, the potential flow of approximately 7,000–10,000 gpm would have been harmlessly diverted by the tunnel to a ravine at the end of the structure. This arrangement, therefore, protected highway traffic from the hazards of a washout, and continuity of water service for Oneida was reasonably assured. The relatively high cost of the tunnel was offset by the employment of steel pipe in long lengths, which permitted overhead rather than underground brook crossings. It was believed that this plan was in the best interests of all parties concerned. Construction costs, which were to be borne by the Thruway, were estimated at $85,000, and the time for completion, at approximately 6 months.

Plans and specifications were submitted to the New York State Dept. of Public Works office at Utica in July 1952. At that time the author reviewed the design in detail and *stressed as strongly as possible the inherent hazards to both the Thruway and the municipality.* The Thruway engineers with whom the author discussed this rather delicate—and, from his viewpoint, highly technical—job were quite competent. Their skill and knowledge, however, lay in the field of bridges and highways, and the technical requirements of water works design seem to have been given little consideration. The plans and specifications were forwarded by the Utica office to Thruway officials in Albany for approval. They were rejected, the author was later advised, principally on account of what were then considered the "excessive costs" of construction.

Alternate Design

The Utica office then directed the author to redesign the line, omitting the pipe tunnel, and have it cross under the Thruway in the slope of the bank of the proposed diversion channel. This arrangement would have virtually prohibited adequate blocking of the two 90-deg bends required, and the line would have been wholly inaccessible for maintenance and repairs, because the Thruway crosses the diversion channel on two bridges having a combined width of approximately 100 ft. When the author pointed out the impossibility of such a route, he was directed to run the main under the Thruway fill, but to employ no pipe tunnel.

New plans and specifications were prepared and submitted in October 1952, this time using the northern route. As the dates for cutting the new diversion channel for the brook and backfilling the old channel were indeterminate, the pipe was run overhead across the existing brook, utilizing very heavy timber pile bents spaced 18 ft apart, center to center. The bank on the far side of the brook was relatively low, and, because the pipeline had to be anchored in it, the average elevation of the line across the brook was well below the annual high-water level. Consequently both the pipeline and the pile bents were likely to be submerged, and the line subject to high-velocity stream flow during spring runoff. To prevent a washout of the bed of the proposed diversion channel, sheet-steel piling was driven from bank to bank, forming cutoff walls both upstream and downstream from the pipeline. The width of this channel was approximately 10 ft, and crushed stone was placed above and below the pipeline.

As the pipeline had to cross under the diversion channel, the specific grade was established for each pipe section. In this connection, it is of interest to note that a 9-in. deflection due to a swing in pipe produces an unbalanced thrust of 1,500 lb, at 250-psi pressure. Line and grade were therefore established with a maximum deflection of only 4 in. per 18-ft pipe length, thus limiting the thrust to 670 lb of unbalanced pressure per joint.

At the two 90-deg bends required for this line, the blocking consisted of triangular-shaped concrete wedges 16 ft wide and 6 ft high. Even this tremendous area had a thrust of 1,700 psf, not allowing for water hammer. Each wedge was attached to a mechanical-joint bend, using ¾-in. round reinforcing rods to secure the bend to the blocking. In order to provide sufficient overload on the second blocking, several feet of additional fill were required, to increase sliding friction. It is obvious that leakage in such a line could only be tested under low pressure, as the line could not be put in service until all the backfill was in place.

Where the line crosses under the Thruway, the cut below existing grade varied from 3 to 12 ft. Because the fill at this point is approximately 19 ft in depth, the pipeline has a bury ranging from 24 to 31 ft. The length of line under the fill is 165 ft. No water works engineer or superintendent with whom the author is acquainted would *voluntarily* make such an installation.

The author has conscientiously endeavored to make this line as safe as possible (considering the mandates imposed by the Thruway) from the standpoint of both the Thruway and the city of Oneida. When any pipeline is laid, however, it must be assumed that a leak or a complete break may occur. If a full break should occur under the Thruway crossing, the 7,000–10,000-gpm possible flow could, and probably would, wash away the fill in a few minutes rather than hours. Were Thruway traffic at such a time reasonably heavy, it would seem that this situation could constitute a real hazard to the traveler. If, in the confusion caused by such a break, a valve were closed off quickly, the water hammer created could rupture the line at many points upstream. There are many recorded instances in which breaks, even in 12-in. mains at 100-psi pressure, have quickly washed out holes the size of eight-room houses, and no one who has ever witnessed such a accident can fail to be impressed with the terrific force of water at high pressure.

If a leak or break occurred, the excavation, sheeting, and repair of this line might require many days, during which all traffic would have to be diverted. The outage of service might be a severe tax on Oneida's domestic, as well as fire-fighting, requirements.

There is what may be termed a "calculated risk" inherent in many engineering projects. In the author's judgment, however, the risk incurred in this installation was, in many respects, unwarranted, as a pipe tunnel would have given adequate protection both to the Thruway and to Oneida, and the difference in estimated costs was negligible. The installation also raises a number of legal questions. For example, should a major break involving loss of life or property occur, who is liable—the Thruway Authority, which dictated the overall policy, or the city of Oneida, which, in fact, owns the line?

Several other phases of the Oneida relocation project likewise reflect con-

flicting viewpoints. For instance, owing to the need for great care in installation, the author insisted that only a contractor experienced in pipe work be authorized to do the job, but the attitude of the State Dept. of Public Works was that no contractor posting a satisfactory performance bond could be disqualified, regardless of lack of experience. Actually, a very conscientious and competent contractor, whose prime contract, however, was for bridge and earthwork in this section, made the installation. In the author's opinion, the successful prosecution of this work was due in no small degree to the fact that the Oneida water works foreman was employed by the contractor to supervise the pipe laying, while the superintendent of the water department served as resident engineer on the job. The overall cost of the relocated line was approximately $105,000.

Suffern Well Field

In the Suffern, N.Y., area, the Thruway was routed through the Ramapo River Valley, just off the village well field. The valley in this section is already somewhat crowded with highways, railway tracks, and high-tension power lines. In addition to the main Thruway, this is also to be the site of one of the principal traffic interchanges. From the standpoint of the Thruway, it is necessary to relocate the Ramapo River approximately 600 ft to the east of its existing course, thereby creating a virtual infiltration gallery within 200 ft of the two municipal wells. In fact, the proposed 100-ft wide diversion channel is located directly over a standby well, which had been developed by the village and reserved for emergency use.

The Thruway Authority officials exhibited considerable thoughtlessness and lack of understanding in this situation. Suffern's first indication that the relocation was under way was the appearance of a Thruway drilling crew, which began to set up operations in close proximity to the wells. A village trustee, John Petrone, took prompt, but rather drastic, action, calling out the local constabulary with shotguns to halt the work. Subsequently, a threatened injunction by the village led the Thruway Authority to agree to pave the entire 3,700-ft long diversion channel, an engineering undertaking of no small magnitude. In view of the cost involved, the length of concrete pavement was later reduced to approximately 1,000 ft. More recently the authority has proposed revetment construction (using bags filled with sand, stone, and cement) in lieu of pavement.

If infiltration from the now cut, but unconnected, flume is negligible, perhaps no protection whatsoever would be required. If, on the other hand, a very high percentage of well water pumped by Suffern is derived from infiltration in this area, then sealing off the flume by a concrete slab could seriously deplete the yield. It is a fact that the river and the well waters are practically identical in alkalinity, hardness, total solids, and chloride content, but iron, manganese, color, turbidity, and coliform organisms are absent in the well water. It appears inexpedient for Suffern to make any further commitments in this matter until satisfactory tests have been run to evaluate the infiltration factor.

Even if Suffern permits this diversion, it must still be decided which party would bear the costs resulting from an appreciable diminution of

yield or impairment of bacteriological quality. At present no chlorination is required, the wells are automatic in operation, and operating costs are nominal. Surely great care should be exercised by the Thruway Authority to prevent any deterioration in either the quantity or the quality of these two wells, which, by virtue of geologic conditions, constitute about the best and cheapest water supply in the state.

Other Controversies

On another job, the author performed a strictly preliminary survey embodying the relocation of approximately $100,000 worth of pipelines. The firm of consulting engineers having charge of Thruway design in this section insisted on its competence in preparing plans and specifications and in supervising this pipeline relocation. It is of interest to note that the final specifications prepared by that firm consisted of little more than the author's preliminary memoranda to the village on the overall aspects of the problem. The author does not believe that satisfactory water works relocation can be effected in such a casual manner.

One of the underlying causes of water works–Thruway controversy is well illustrated by an interchange of correspondence between a certain village and a Thruway official regarding pipeline relocation problems. A letter of inquiry from the village read:

> As our village reservoir is located on the mountain north of the proposed Thruway route, and a 12-in. main runs down the mountain from the reservoir to the village, this item is of great importance to us. The Village Board feels that we should retain the services of an engineer as regards this phase of the local utilities. At the present time we do not have a village engineer. The Village Trustees desire to know if there is anything in the state regulations regarding Thruway construction, whereby the village could hire an engineer to be used on work pertaining to the Thruway—as it affects our utilities—and the state would pay the engineers compensation. The Board feels that this engineer would not have to be hired, were it not for the fact that the Thruway is going through this village.

The Thruway official replied:

> This office is of the opinion that our firm of contracting engineers is fully capable of designing any such required alterations, provided that the firm is fully informed with regard to the exact location of the present equipment. We can certainly not see the justification of hiring an additional consultant for the purpose of representing the village, as we believe our contracting engineer fully capable of protecting the best interests of the village as well as those of the Authority.

With all due respect to the undoubtedly high capabilities of the engineering firms employed by the Thruway Authority, and with every appreciation of its engineering talent, the incidents cited in this paper indicate a rather complete unfamiliarity with water works practice, as well as a rather complete lack of awareness that water works relocation can be hazardous and requires careful and competent design by persons qualified in this specific field of engineering.

In another instance, a lengthy phone conversation with a Thruway official ended in a complete lack of understanding, as the official's entire concept of wells seemed to be founded on a cursory knowledge of common rock holes, where the price of drilling is often based on a linear-footage charge of,

say, $5–$10 per foot. The installation in question was not a rock hole, but a gravel-packed, hydraulically developed well, with 20 ft of 8-in. screen set at a depth of approximately 80 ft. The author was utterly unable to convince this official that the overall cost of gravel-packed wells cannot be estimated in the same way as for rock wells. Such incidents are an indication that the fields of professional competence of the parties involved are too far apart for any rational meeting of minds.

One wonders why the Thruway officials have not called on the good offices of the state and county health departments, and on the New York State Water Power and Control Commission, to interpret for them the water works problems involved. Surely these agencies are well aware of the overall water works situation prevailing in every city and village in the state. The personnel of these agencies are highly competent and could, if brought into the picture, be of real assistance to the Thruway, as well as to the communities involved.

Many simple water works relocation jobs can undoubtedly be competently handled by highway and bridge engineers. Until the water works profession, however, can convince highway authorities throughout the United States that such projects as the relocation of major water transmission mains and major changes in well fields require individual study and are often outside the competence of the general civil engineer, and until highway officials can *affirmatively and genuinely* accept this thesis, there seems little prospect for ending confusion and disputes in the future.

Conclusion

The author hopes that this brief description of his relations with the New York State Thruway will be of some service in pointing out to highway officials that the people they serve need water works as well as roads; that pipeline relocation is sometimes hazardous and requires every engineering consideration; that water works engineers are as interested in doing a good job in their technical field as highway engineers are in theirs; and that the former, at least, must deal with highly specialized problems of mechanics, hydraulics, biology, and chemistry which may not be apparent to, or appreciated by, those who construct highways and bridges.

The Thruway Authority is doing a magnificent job. By devoting a little more consideration to the viewpoint of other engineers, it can undoubtedly do even better.

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Discussion

A. G. Giannini

Supt. of Operations, Dept. of Water Works, Hammond, Ind.

The relocation difficulties encountered in New York State can readily be appreciated by Indiana water works men, who have been faced with similar problems. In Indiana, however, it is primarily a divergence of legal rather than engineering viewpoints that has caused trouble with highway designers.

The representatives of the Indiana Highway Dept. have always been very prompt to order water mains relocated wherever possible. If relocation is im-

practical, a casing sleeve through the fill is required. Water works engineers will readily agree to pipeline relocation, if reasonable provision for maintenance is made. A water main buried under a 20–30-ft highway fill becomes a serious and costly maintenance problem. Highway engineers are too often interested only in the economy of their design and neglect safety and maintenance considerations vital to water works facilities.

Such oversights can result in grave situations, as an experience at Hammond, Ind., will attest. In the summer of 1953 a 12-in. water main carrying 45-psi pressure was buried under a 20-ft highway fill. Just after the state highway department had completed the fill, but before the overpass was opened to the public, the main broke at two o'clock in the morning. When the water department repair crews arrived at the scene, they found that a hole large enough for a house had been washed out of the sand fill adjoining the bridge abutment. The crews worked without interruption until two o'clock the following morning to repair the break. Meanwhile a town of 8,000 population was without water during the hottest 24-hr period of the summer.

The deep bury not only delayed the restoration of service but made the repair work excessively expensive. On the advice of attorney, the city did not replace the roadway fill, so that the contractor or the state highway department had to bear that cost. Thus, both parties suffered damages that would have been avoided if the existing main had been relocated beyond the fill.

Two other sections of 12-in. main in Hammond were buried under high fills during the construction of a superhighway. Approximately 600 ft of line is under a 25-ft fill, while another 1,300 ft is under a 30-ft fill.

Throughout negotiations extending over a span of several years, the city water department and the state highway department have concurred in the need for main relocation, but each party has continually insisted that present state statutes require the other to pay the costs. Both groups of public officials feel that they cannot disburse public funds until the legality of the procedure has been established beyond question. Furthermore, the water department has not had ready funds to undertake this work, because of sorely needed major improvements.

Many other Indiana cities are confronted by similar situations. The wide right of ways required for modern superhighways and the high fills over the many grade separations are causing the costs of relocation to increase appreciably. In the past when roads were built at ground level, these difficulties were relatively minor. After a water department has acquired "prior rights" in a long established city street, it seems grossly unjust for the highway department to refuse to pay for damage to the distribution system caused by superhighways.

There is evidently a great need for engineers, lawyers, and legislators to get together and arrive at an equitable solution to this increasingly vexing problem. The traveling public and the water-consuming public are equally deserving of consideration.

Paul Weir

Gen. Mgr., Water Works, Atlanta, Ga.

A 20-mile freeway system being constructed by Atlanta, Ga., has created many problems for the Atlanta Water Works. This highway, when com-

pleted, will have required the adjusting of water mains, varying in diameter from 6 to 48 in., at approximately 135 different sites. As pointed out by the author, the relocation of large, and even of small, water mains requires careful planning by engineers well versed in the highly specialized field of water distribution. One pipeline break has already occurred, in a large-diameter main over which 21 ft of fill had been placed for a bypass highway.

Interagency Cooperation

In planning for the freeway construction, the Georgia Highway Dept., its engineering consultants, the US Bureau of Public Roads, and other utilities have cooperated satisfactorily with the water works. The procedure has been as follows: First, a set of preliminary plans of the proposed freeway section is forwarded to the engineering department of the water works and to the other utilities. All existing utility structures are plotted, and the plans are returned to the State Highway Dept. Revised plans for the highway section, showing the utility installations, are then sent to the water works engineering department, which designs and makes drawings for the adjustment of the affected water works structures. These drawings, together with cost estimates, are returned to the State Highway Dept. for the drafting of final plans. Finally a conference of all interested parties is held. A force-account agreement is worked out, and the adjustment of all water mains is accomplished by Atlanta Water Works personnel. To date neither the State Highway Dept. and its engineering consultants nor the US Bureau of Public Roads engineers have questioned the adequacy of the water works plans or the cost estimates presented. The demarcation line between the cost of adjusting existing structures and the cost of installing larger mains to allow for future expansion has, however, been the cause for some discussion.

In several instances, the water works has had to dead-end minor feeder mains for several months during construction of the freeway. This has decreased the reliability of the system in some areas, but has not materially affected service. The adjustment of major arteries has been carefully planned and coordinated with the freeway contractors, so that outage time could be kept to an absolute minimum.

The freeway system is a venture jointly financed by the city of Atlanta, Fulton County, the state of Georgia, and the US Bureau of Public Roads. The fact that Atlanta is financially interested in these projects and has high-echelon representation has, no doubt, been largely responsible for the consideration received by the utilities in the planning phase.

In addition to the freeway system, approximately 7 miles of bypass or expressway streets has been built in Atlanta. One 3½-mile expressway, which, like the freeway, is a divided road, necessitated the adjustment of water mains at 46 street intersections. Engineering work on the project, which was financed entirely by county bonds, was done by a private consultant, subject to inspection by the State Highway Dept. As with the freeway system, satisfactory cooperation was extended to the water works.

Difficulties Experienced

Another 3½ miles of divided highway was financed by both county and federal funds, the engineering work

being done by the State Highway Dept. The route traversed by this expressway was not thickly populated, and it crossed only minor distribution mains at four points. At two points, however, it crossed the 48-, 36-, and 30-in. raw-water mains that extend from the river to a reservoir at the filtration plant.

As this highway was constructed along an abandoned trolley right of way, little or no change was made in the existing grade. The engineers planning the highway apparently failed to realize the need for careful protection of the raw-water lifelines of the city. At one point, the trolley had passed over a bridge above a street in which the three raw-water mains and an 8-in. potable-water main were laid. When the trolley line was abandoned, this bridge was removed. In constructing the expressway, the street was closed and the underpass was filled in to eliminate rebuilding the bridge. As a result, all the mains were buried to a depth of 21 ft.

Shortly after this fill had been completed, but before the highway was finished, the 48-in. main broke. In a few minutes, before the pumps could be shut down and the main isolated, a huge hole was washed in the fill. It was necessary to use a steel erecting crane with a very long boom—to keep the machine on safe, firm ground—in order to remove the dirt and broken pipe and to lower the new pipe into place. Working in continuous shifts, the crews required a day to make the repairs and three more to replace the fill. Had the highway been in service, it would have been closed to all traffic at least 2½ days.

In the opinion of the cast-iron pipe manufacturer's representatives, the break in this 48-in. main was caused by excessive external load. It is therefore assumed that, if proper provision had been made for the protection of the mains at this crossing, the break would not have occurred. This section of expressway was the only one about which the water department engineers were not consulted and the only one where trouble has developed as the direct result of highway construction.

Atlanta's experience bears out the author's contention that designing the relocation of water mains requires the skill of engineers trained in the highly specialized field of water distribution. This observation applies also to pipe-laying contractors. During the last three years the Atlanta Water Works has laid approximately 100 miles of main each year, most of it under contract. Unless a bidder has an extensive background in laying large and small water pipe on a scale similar to the work called for in the proposal, he is disqualified even though he may be a conscientious, competent contractor in other fields.

Establishing Emergency Operating Procedures for Water Systems

By John D. Wedeman

A paper presented on Oct. 21, 1953, at the Southwest Section Meeting, Houston, Tex., by John D. Wedeman, Chief, Water & Sewage Branch, Engr. Section, Fourth Army, Fort Sam Houston, Tex.

THE natural self-confidence of the American, which has been such an important factor in the country's progress, is not a characteristic conducive to preparing for unforeseen catastrophes. Rather, it encourages a tendency to deal with each situation as it occurs, assuming the same degree of success in contending with an emergency as in overcoming obstacles encountered in normal progress. This is not a philosophy which water works men have a right to adopt, because they are responsible for the health and well-being of the public.

There are, of course, limits to how far the conscientious water works official can go in preparation for disaster. For example, the water works superintendent, alone, cannot prepare for defense against enemy attack; to meet such an eventuality requires a coordinated effort, including the use of resources not under his control. He can, however, formulate a plan of action, utilizing locally available resources to the fullest extent, in order to cope with all emergency conditions resulting from other than enemy activity. An emergency operating procedure, in the form of an established plan providing for prompt action in an orderly manner to prevent or mitigate the damage of accidental disaster, should also prove of value in disaster due to war or sabotage.

Furthermore, the process of developing a satisfactory emergency operating procedure entails analytical examination and constructive action of a nature that will materially aid normal operation. This beneficial effect is likely to outweigh by far the cost of preparing the procedure for emergency operation.

The plan of action should be based upon the potential causes and effects of emergencies and the resources available for meeting them. Potential causes may be determined from the records of the water works, supplemented by consideration of water system deficiencies and the possibility of uncontrollable natural occurrences. Some factors worthy of study include:

A. Power failure
   1. Causes
      a. Storms—electrical, wind, ice
      b. Strikes
      c. Plant breakdown
   2. Frequency
   3. Extent
      a. Duration
      b. Facilities affected
   4. Effect on water supply

B. Water plant failure
   1. Causes
      a. Obsolescence
      b. Inadequate maintenance
      c. Improper design
      d. Faulty construction
   2. Frequency
   3. Extent
      a. Duration
      b. Facilities affected
   4. Effect on water supply

C. Structural failure—dams, pipelines, storage tanks

1. Causes
   a. Soil movement
   b. Corrosion
   c. Faulty construction
   d. Improper design
   e. Floods
2. Frequency
3. Duration of inoperative period
4. Effect on water supply

D. Contamination—mineral, biological, radiological
1. Causes
   a. External to system—industrial or domestic waste disposal
   b. Within system—cross connections, structural deficiencies, improper design, ineffective protection during repairs or alterations

E. Floods
1. Frequency
2. Extent
3. Effect on water supply

F. Droughts
1. Frequency
2. Duration
3. Effect on water supply.

Although floods and droughts are included in the outline, these items should be the subject of separate engineering studies if they are determined to be potential causes of major emergencies.

The next step is a thorough study of the available resources. The normal operating procedure, if properly prepared, will provide this information. To be of any value, the normal operating procedure must be in written form and should include at least the data covered in the following outline:

A. Description of water works
1. Verbal description of capacities of facilities and their function
2. Maps of entire system
3. Inventory
   a. Installed equipment
   b. Mobile equipment
   c. Stock levels and points of issue—normal and standby

B. Operating guides
1. Shutdown procedure
   a. Comprehensive plan of system
   b. Valve location sketches
2. Flow and pressure schedules
3. Preventive-maintenance schedule

C. Policy of operation
D. Organization
E. Pertinent laws and ordinances.

The thoroughness of the review of the normal operating procedure, including the analysis of the existing facilities and the effectiveness of the corrective action taken to remove deficiencies found in the methods of operation and in the available facilities, will be the primary factors in determining the success of the emergency operating procedure. The adequacy of the resources is governed not only by the design capacities of the various facilities but also by the manner in which they are operated and maintained. The analysis of operational procedures should reveal weaknesses in the organizational structure requiring reinforcement, as well as the location of surplus personnel that can be shifted in emergencies.

It will be found, ordinarily, that many emergencies are no longer potentialities through removal of their causes by improvement of the normal operating procedure. The remaining potential emergencies should be classified as to imminence and seriousness. Such terms as "immediate" (no time for preparation), "impending" (allowing a brief period for preparation) and "remote" (ample time for careful planning) might be employed. Each type of emergency should also be classified as "major," "limited," or "minor." All of these terms require precise definition based upon local conditions. An emergency regarded as major in one system might be considered merely limited in another. These classifications will serve to establish the scope of responsibility and the degree of authority under

various conditions and will aid in formulating the general plan of action.

The emergency organization should be developed with the maximum practicable utilization of the regular organization personnel. Alternates should be provided for all key supervisory jobs, and alternates or assistants for minor supervisory jobs. Promising subordinates should be allowed to act in supervisory positions under observation. Retired former employees may often be used successfully as alternates. If personnel outside the organization are scheduled for key jobs, it may have a demoralizing effect on the regular employees. Great care should be taken to assure specific descriptions of scope of responsibility and degree of authority.

The plan of action should clearly designate the positions and organizational divisions responsible for each emergency category, and should be devoted to the overall administration of the assigned functions of the organization. The details of execution must be left to the judgment of the authorized personnel. Many of these details, such as shutdown and sterilization procedures, will be part of the normal operating procedure.

A liaison plan, usually required for major emergencies only, should be developed after all other phases of the plan have been at least tentatively established. The liaison plan should include adequate information concerning the extent of support that can be depended upon from other departments of the local municipality, from adjoining municipalities, and from commercial enterprises, such as contractors and supply houses. The specific steps of procurement procedure should be written out and agreed upon by the officials in charge of the sources of procurement.

The emergency operating procedure should be compiled in a loose-leaf manual, so that it can be kept current without the necessity for rewriting the entire procedure. The essential items in the manual include:

A. Classification of emergencies—definition of categories
B. Organizational structure
   1. Functional chart
   2. Delineation of authority and responsibility in accordance with emergency classifications (position titles should be used rather than names of individuals)
   3. Alphabetical list of key positions by titles, followed by names of assigned personnel and their alternates
   4. Alphabetical list of names of key personnel, with addresses and phone numbers
C. Plan of action for each emergency category
D. Liaison plan
   1. Civil support
      a. Public works department
         i. Extent of support—personnel, equipment, materials
         ii. Procurement procedure
      b. Police department
      c. Fire department
      d. Health department
      e. Adjoining municipalities
         i. Extent of support—water supply, personnel, equipment, materials
         ii. Reciprocal agreement
   2. Commercial support
      a. Contractors
         i. Extent of support—personnel, equipment, materials
         ii. Procurement procedure
      b. Supply houses
         i. Extent of support—equipment and materials
         ii. Procurement procedure
E. Normal operating procedure (complete).

The careful formulation of a procedure such as that outlined above will do much to insure the restoration and maintenance of adequate water supplies during periods of emergency.

Experience With Mechanical-Joint Pipe in the Washington Area

Panel Discussion

A panel discussion presented on Oct. 29, 1953, at the Chesapeake Section Meeting, Wilmington, Del.

Roy L. Orndorff

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IN 1942 a little more than a mile of 24-in. mechanical-joint cast-iron pipe was installed at Washington, D.C. Although the department was impressed by the advantages of such joints, restrictions and scarcity during the war and postwar years limited their use to occasional projects. In 1949 mechanical joints were adopted as standard for 8-in. pipe, that size being the smallest normally employed in the grid system and constituting by far the major proportion of pipe used. By the autumn of 1953 approximately 250,000 ft of mechanical-joint pipe had been installed. In addition to the almost exclusive use of mechanical joints on 8-in. pipe during the past 4 years, Washington has laid considerable quantities of such pipe in other sizes, from 4 to 24 in. Mechanical joints were made standard for 12-in. pipe in 1951 and for the 4-in. and 6-in. sizes in 1953. The principal reason for making the change gradually rather than in all sizes at once was that the available yard space and facilities could accommodate only a part of the stock of fittings which must be carried for both bell-and-spigot and mechanical joints during a transitional period of several months to a year. Incidentally, it is anticipated that it will be necessary to maintain a permanent minimum stock of bell-and-spigot fittings for repairs, maintenance, and special jobs. It has not yet been decided whether to standardize on mechanical joints for 16–24-in. pipe, because mechanical-joint pipe in these sizes is cast to Class *B* diameters, whereas great quantities of centrifugally cast pipe with Class *C* diameters are now installed. The confusion and delays that would ensue if an attempt were made to use mechanical-joint fittings in these sizes must be fully considered before adopting the change.

Advantages

The results obtained with mechanical-joint pipe thus far, considered from the standpoint of convenience, safety, economy, and ease of maintenance, have been eminently satisfactory. Experience indicates that mechanical-joint pipe in place costs somewhat less than lead-jointed, but slightly more than sulfur-jointed, bell-and-spigot pipe. The price differential between mechanical-joint and the other types of pipe is not significant, however, as it is so small—20 cents per foot for the 8-in. size—in relation to the total cost of mains in place.

Construction crews find that the certainty and facility with which perfectly

tight mechanical joints can be made under unfavorable trench and shutoff conditions are of inestimable value. Mud or water in the trench bottom or pipelines is no problem whatever with these joints. It should be pointed out, however, that these joints, with all their simplicity, are not absolutely foolproof. In several instances, the application of test pressures has revealed leaks that the contractors have found it rather expensive to locate. These have occurred at joints in which bolts had been omitted or left loose or in which gaskets had been forgotten.

In regard to sanitation, the mechanical joints represent some improvement, although the disinfection process is much the same as for bell-and-spigot pipelines using the rubber ring gaskets adopted some years ago for lead and sulfur joints.

Of all the advantages claimed for mechanical-joint pipe, the most important is the flexibility of the resulting pipeline and the ability of the completed joints to move within relatively high limits without developing leakage. This pipe has often been laid on fills that were not completely consolidated and on which the department would not have considered placing bell-and-spigot pipe; in none of these instances has there been any trouble with breaks or leaking joints.

Shortcomings

The chief cause for concern so far encountered was the rather frequent breakage of bolts when mechanical joints were first used on a large scale. A number of bolts tested in tension and subjected to metallurgical analysis were found to be erratic in strength and composition, although always at least as strong as the specification requirements. After the matter had been discussed with the pipe foundries, the working crews were provided with torque-limiting wrenches, so that the men could adjust the tightening to the recommended torque. The breakage of bolts then diminished nearly to zero. Bolt tests made in September 1953 revealed much better uniformity of strength, and again all bolts tested exceeded the specifications.

Another unfavorable aspect that has been observed, but on which no pertinent statistics are available, is the more frequent breakage of mechanical-joint pipe bells in transit, in comparison with bell-and-spigot pipe. Wider realization of this hazard and better placing of dunnage will probably reduce such breakage.

One problem connected with the use of mechanical joints is a result of their virtues. When, for any reason, it is necessary to install bell-and-spigot pipe, the construction forces are made most unhappy. On one such job recently, the author asked the complaining foreman how he would feel if the department were to revert to the general use of bell-and-spigot pipe. If that happened, the foreman said, he thought he would find another job.

Washington's experience with mechanical-joint pipe has been very satisfactory. In fact, valves and fire hydrants with mechanical joints are now being made standard.

Justin E. Farrell

Engr., Constr. Div., Washington Suburban San. Com., Hyattsville, Md.

The Washington Suburban Sanitary Commission bought its first mechanical-joint cast-iron pipe in March 1950. It was so favorably received by the contractors and by the commission's own

construction gangs and supervisory personnel that it has been used almost exclusively since. The following observations on the use of such pipe represent the opinion of the commission's construction division engineers after 3½ years' experience with it.

Mechanical joints can be made more easily and much faster than poured joints. The use of a "hot pot" and a "hot pot" man is eliminated, as are the delays caused by a jointing compound that is too hot or too cold when needed. Also, the possibility of injury from burns to the workmen is eliminated.

Tighter joints can be expected. When the mechanical joint was first adopted, the author carefully inspected each joint on several thousand feet of pipelines of various sizes after they had been connected to the existing system and were under pressure. No leakage was found.

Good joints can be made under wet conditions as well as in a dry trench. This advantage is particularly important when new mains are being connected into the existing system. Even when the valves in the system are completely closed—unless they are at the end of the existing pipe—water must be drained from the trench where the hookup is to be made. The resulting sloppy trench conditions frequently cause leaky joints when bell-and-spigot pipe is employed. If it is impossible to close an existing valve completely and the connection has to be effected while some water is running through the pipes, working with lead or sulfur compounds is extremely difficult and conducive to poor joints. No such trouble is encountered with mechanical joints.

Laboratory records indicate that no appreciable difference in bacteriological results is attributable to mechanical joints. For a year prior to the use of such joints, 96.0 per cent of the water samples taken after the disinfection of new mains were satisfactory. In a similar period, 96.2 per cent of the samples of water from mechanical-joint pipe after disinfection were acceptable. Thus, the difference between mechanical joints and other types amounts to only 0.2 per cent.

Although good mechanical joints are to be expected, leaks do occasionally occur. They are almost always the result of failure to tighten all the bolts sufficiently. The use of a torque-limiting wrench is a simple remedy. Of course, leaks owing to defective or damaged pipe can occur regardless of the type of joint. Because the conditions under which these breaks must be fixed are essentially the same as those encountered when connecting a new main into the existing system, the repairs can be made more easily and satisfactorily when mechanical-joint pipe and fittings are used.

It has been found that most workmen handling mechanical-joint pipe for the first time seem to think that proper bracing of bends, fire hydrants, and dead ends is not important. The crews are under the false impression that the pipe and fittings are being bolted together, although the fact is that the nuts and bolts only clamp the gasket and gland to the bell. Fire hydrants, in particular, must be well braced or they will not remain plumb during backfilling and puddling or tamping of the trench.

Bell-and-spigot fittings are preferable to mechanical joints in situations where a number of fittings are used together. The proper selection of fittings will eliminate the need for nipples. The commission's practice on large mains is to use valves one size smaller than the pipe, two reducers

being required. If a hub end valve and two large bell increasers are used, a compact assembly results. Very often the assembly is made on the bank and installed as a unit.

A minor but sometimes costly disadvantage of mechanical joints is that the nuts and bolts appear to be easily lost or stolen. On at least one occasion, the entire supply for a project disappeared on the job, and smaller amounts must be frequently replaced.

Unless constant vigilance is maintained by inspectors and supervisors to insure that soapy water is used on the joints and gaskets and that properly set torque-limiting wrenches are employed, these procedures will be quickly discontinued and forgotten by the workmen. They especially dislike soapy water in cold weather. Torque-limiting wrenches, which cost approximately $17 and may not be obtainable locally, do not last very long, probably because of the rough treatment they receive.

Comparative figures on the actual cost of laying mechanical-joint and other kinds of pipe are not available. An analysis of bids received on 56 contracts over an 8-month period during which both bell-and-spigot and mechanical-joint pipe were being used indicates no significant price differential. The attitude of the contractors, however, is sometimes revealing when the pipe to be laid is furnished by the commission. The laying specifications state whether the pipe will be mechanical joint or bell and spigot. Occasionally the type on which the contractor bid is not available in the storeyard when he is ready to use it. Whenever bell-and-spigot pipe has to be substituted for the mechanical-joint variety, the contractor's complaints are loud and vigorous. But if the situation is reversed and he is told that he can have mechanical-joint pipe instead of the bell-and-spigot pipe on which he has bid, the news is always received cheerfully.

It is believed that results of more than 3 years' experience with mechanical-joint cast-iron pipe have justified the optimism which was felt by all concerned when its use was originally adopted.

Considerations in Selecting Distribution Storage Facilities

By M. D. R. Riddell

A paper presented on Mar. 18, 1954, at the Illinois Section Meeting, Chicago, by M. D. R. Riddell, Engr., Greeley & Hansen, Chicago.

THE selection of distribution storage facilities usually constitutes only one phase of an overall study to determine the deficiencies of the existing distribution system and the improvements necessary to correct them and provide for future expansion. If additional storage is indicated, the study must determine the volume, type, and location. If funds are limited, as frequently happens in practice, it may be necessary to balance the advantages of additional storage against those of other improvements, such as larger mains, and to establish construction priorities.

Several years ago, the author's firm was called upon to make such a study for Lake Forest, Ill. The final recommendation, based on this study, was that a 2-mil gal ground storage reservoir and booster pumping station be built on a site owned by the city on the opposite side of town from the treatment plant and main pumping station. This reservoir was to be the first item in a construction program including new feeder mains and a new pumping station, all of which were to be completed by 1960. As the steps leading up to this recommendation are fairly typical, they may be of interest as an illustration of the general procedure followed in dealing with problems of this type.

The problems presented at Lake Forest during the summer of 1948 were those of inadequate pressure in the distribution system and inability to meet the requirements for water during days of maximum use. On Aug. 24–25 the 200,000-gal elevated tank was virtually depleted, in spite of the fact that the pumping station was operating at maximum capacity and that, by request, none of the three golf courses was using water for sprinkling. The capacity of the treatment facilities under the raw-water conditions prevailing during this period is more than 6 mgd. The quantity of water that could be delivered into the system during 24 hr was, however, limited to 4.8 mil gal by inadequate distribution facilities. The obvious solution, therefore, was to increase the effective capacity of these facilities by the construction of additional storage on the distribution system, additional feeder mains, or a combination of both.

The demand for which these facilities should be designed was obviously related to the sprinkling load, as the average winter use of water was less than 1.0 mgd. Earlier studies at Lake Forest and at other communities in the vicinity had indicated a peak sprinkling demand of 4 gpm per acre of developed area. Applying this factor to an esti-

mate of the extent and probable distribution of the developed area within the city by the year 1960, a probable peak demand rate of 15 mgd was established. It was determined that the minimum pressure on the distribution system should not be less than 35 psi, and that the maximum discharge pressure at the main pumping station should not exceed 105 psi.

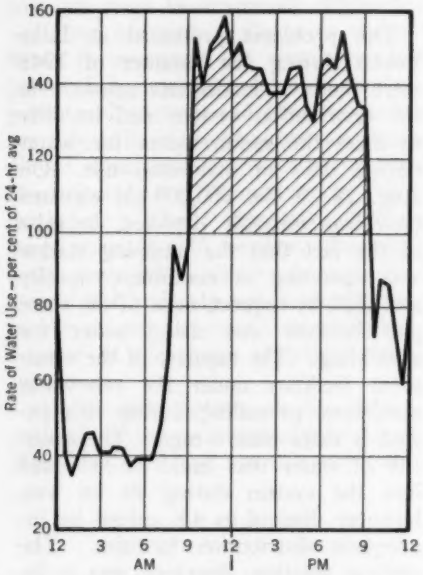

Fig. 1. Hourly Variations in Water Use

The shaded area represents the volume of storage required to meet all peak demands while pumping at the average rate for the day.

The sizes and locations, and, hence, the estimated costs, of additional feeder mains to provide for distribution at the predicted peak demand rate—both with and without additional storage on the system—were readily determined from analyses of the flows and head losses within the system, using the conventional Hardy Cross method. To compare the costs of various combinations of feeder mains and storage, it was also necessary to estimate the costs of the latter. These are related to the volume of storage required, the kind of storage, and the site on which it is to be built.

Storage Volume

The volume of storage required depends upon the purpose for which it is intended. In this instance, the primary purpose of the storage was to equalize the pumpage rates at the main

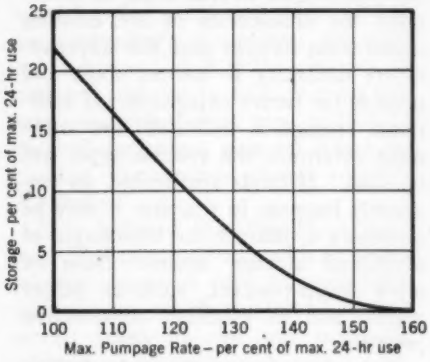

Fig. 2. Effect of Storage on Maximum Pumping Rates

A small volume of storage can result in a considerable reduction in the peak pumping rate.

pumping station and, by thus lowering the peak rates, to permit a reduction in the size of the feeder mains needed. The volume of storage required can be determined from the hourly variations in pumpage on the maximum day. It will vary from approximately 10 per cent to 25 per cent of the total pumpage during that day, depending on the size and character of the city.

Figure 1 shows the hourly variations in pumpage at Lake Forest during a maximum day (Aug. 24, 1948), expressed as percentages of the

average 24-hr pumping rate. The shaded area under the curve represents the volume of storage required to meet all peak demands during the day while pumping at a uniform rate equal to the average for the day. The necessary storage is equal to approximately 22 per cent of the total water used during the day. Table 1 shows the corresponding volumes of storage required to equalize the pumpage rates on maximum days in a number of different cities.

The peak hourly rate of pumpage on the maximum day at Lake Forest is approximately 160 per cent of the average rate for that day. For a peak rate of 15 mgd, the corresponding average rate would be approximately 10 mgd, and the volume of storage required to equalize the pumpage on that day would be 2.2 mil gal.

A considerable reduction in peak rates can, however, be accomplished with very much smaller volumes of storage, as shown in Fig. 2. The existing elevated storage, which represents only 2 per cent of the total pumpage predicted for the maximum day in 1960 would, for example, be sufficient to reduce the peak rate of pumpage required from approximately 160 per cent to 143 per cent of the average for the day. An additional 900,000 gal of storage would effect a further reduction in maximum pumpage rates, to approximately 120 per cent of the average for the day.

Besides reducing the maximum pumpage rates and permitting a saving in the size of feeder mains, storage on the distribution system provides a ready reserve in the event of fire, power failure, equipment breakdown, or other interruption in service. The volume of storage recommended by the National Board of Fire Underwriters (*1*) as a reserve for fire protection is shown in Fig. 3. For an estimated 1960 population of 9,000 at Lake Forest, 1.8 mil gal of storage would be needed. Additional storage of 2 mil gal to equalize the pumpage on the maximum day would more than meet this requirement. With an average winter use of less than 1 mgd, this

TABLE 1

Water Use and Storage Required

Item	Lake Forest, Ill.	Highland Park, Ill.	Waukegan, Ill.	Niagara Falls, N.Y.	St. Petersburg, Fla.
Population (1950)	7,819	16,808	38,946	90,872	96,738
Character of city	resid.*	resid.*	indus.†	indus.†	resid.*
Water use					
Annual avg—*gpcd*	215	110	120	400	82
Max. day—*gpcd*	645	330	180	500	108
Max. day—*per cent of annual avg*	300	300	150	120	143
Max. hour—*gpcd*	970	495	300	580	200
Max. hour—*per cent of annual avg*	450	450	250	145	245
Equalization storage—*gpcd*	142	66	20	40	27
Equalization storage—*per cent of 24-hr use*	22	20	11	8	25

* Residential.
† Industrial.

storage would provide more than 2 days' emergency supply, assuming that appropriate conservation measures were in effect.

Type of Storage

Once the volume of storage required at Lake Forest to accomplish the desired reduction in pumpage rates had been established, it was necessary to choose the type of storage to be provided. The choice of ground storage in this instance was based partly on cost and partly on aesthetic considerations. Figure 4 indicates that the first cost of a 2-mil gal ground storage reservoir and pumping station would be approximately $170,000, half the cost of an equal volume of elevated storage. (Because the pumping station constructed was somewhat more elaborate than would ordinarily be required and because it was necessary to limit the height of the top of the reservoir above original grade, the actual first cost of the ground storage installation at Lake Forest was approximately $200,000.)

Local conditions will have little effect on the cost of elevated storage except as they influence the height of the tank above ground. Special requirements may increase the cost of ground storage, as at Lake Forest. On the other hand, substantial economies can be realized with ground storage when the tank may be located above the ground.

Although the first cost of ground storage is usually less than that of elevated storage, the annual operating cost will be somewhat higher because of the necessity for repumping. Whether this amount is enough to compensate for the higher fixed charges on elevated storage will depend largely on the rates for electric power and the method of

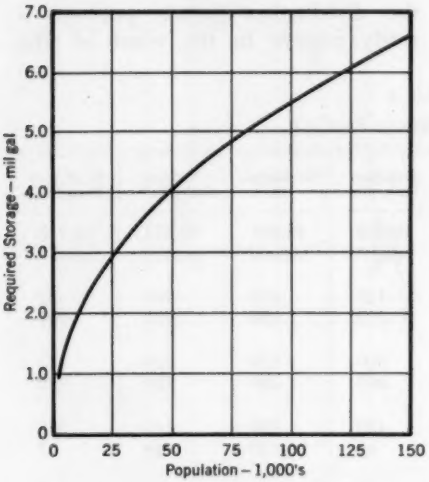

Fig. 3. Fire Reserve Requirements

The curve is based on National Board of Fire Underwriters recommendations (1).

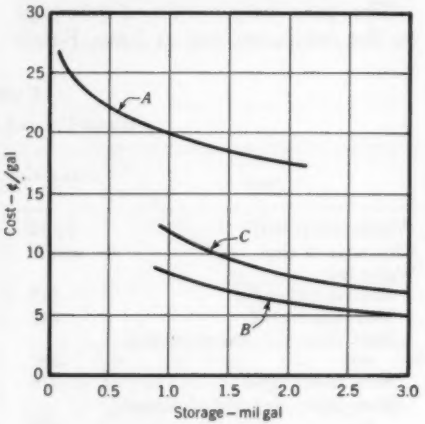

Fig. 4. Storage Cost Comparisons

A—*elevated storage;* B—*ground storage;* C—*ground storage reservoir and pumping station.*

computing the charge. At Lake Forest, where the need for additional storage exists during only a few months of the year, the cost of repumping was small and was not a controlling factor in cost comparison.

Additional advantages of ground storage, which had little influence on its selection over elevated storage at Lake Forest, but which might assume greater significance at other locations, include the following: [1] ground storage reservoirs do not present a hazard for aircraft operation and can, therefore, be situated in close proximity to airports and airfields; [2] such reservoirs can be filled more easily than elevated tanks during periods of offpeak pumpage; [3] ground storage can be used to boost local pressures above the prevailing hydraulic gradient to provide increased flow for fire fighting; and [4] ground storage reservoirs are less vulnerable than elevated tanks to damage by windstorms or enemy action.

One disadvantage of ground storage, particularly for a small community, is that it usually requires manual operation of the pumps. Automatic pump control in response to changing demands for water can, however, be effected by the use of selected pressure control points on the distribution system or through changes in the water level of existing elevated tanks.

The apparatus required for such control is relatively complicated and expensive and may depend for its successful application on the availability of telephone or telegraph wires that can be leased as control circuits. The location of suitable pressure control points presents other problems. Consideration was given to the installation of such equipment at Lake Forest, but, as the main pumping station is continuously attended, it was decided to install remote supervisory control at this station instead.

Among the advantages of elevated storage are its ability to respond automatically to changing demands for water—thus maintaining relatively constant and uniform pressures throughout the distribution system—and its immediate availability at the desired pressure without repumping The first of these advantages may be of particular importance to a small community, where the pumping station may not be continuously attended, in that it insures a ready supply while pumps are being started to meet the increased demand. Elevated storage may also make it possible to take advantage of offpeak rates for electric power.

Some elevated storage on the distribution system is almost always desirable, in order to maintain a uniform head on the pumps and reduce the number required to cover the anticipated range of operating conditions. A frequent arrangement is to provide sufficient elevated storage to compensate for all or a part of the variations in pumpage during the maximum day, using ground storage for the remainder. It was decided that the existing elevated storage at Lake Forest was adequate for this purpose. It should be pointed out, in this connection, that, for 8–9 months of the year, the existing elevated storage is nearly sufficient to equalize all variations in pumpage during the day.

Location of Storage

With the volume and type of storage determined, the question of where to put the reservoir will usually resolve itself into a choice between two or three available sites. At Lake Forest, the alternatives included one site near

the center of the distribution system and a second closer to the city limits. The first site, which was rather small, was privately owned and would have had to be acquired by the city. The second site was owned by the city and was of ample size to facilitate construction operations. The first was adjacent to a number of principal feeder mains, while the second required the laying of some additional mains. Analysis of the distribution system, including these new mains, indicated that storage at either site would be about equally effective in improving pressures throughout the system, although storage at the second site would be slightly more effective for the southwest portion of the city, where the greatest potential for future growth is believed to exist. Electric power and telephone cables were available at both sites and both were accessible from paved roads.

The second site would involve a higher initial cost because of the need for immediate construction of feeder mains. These mains would, however, eventually be needed to complete the distribution loop, whichever site was chosen. This fact, together with the possible effect of the restricted working space at the first site on the cost of construction, tended to offset the influence of the estimated cost differential on the choice between the two sites. Accordingly, the second site, which was already owned by the city, was selected.

Conclusion

The ground storage reservoir at Lake Forest has increased the effective capacity of the distribution system so that it is now possible to deliver, at adequate pressures, more than 6 mil gal during the maximum 24 hr, at maximum rates up to 9 mgd. Before the construction of the ground storage facilities, the maximum rate of delivery was limited to approximately 7.2 mgd, and the total 24-hr pumpage to 4.8 mil gal, both at inadequate pressures in portions of the system. The immediate increase in effective capacity is, therefore, approximately 25 per cent. By accepting somewhat lower pressures on the distribution system, a 24-hr total pumpage of 7.2 mil gal, or a 50 per cent increase in effective capacity, would be possible. This amount, however, is more than the present capacity of the treatment facilities during seasons in which such a demand is likely to occur.

Additional feeder mains and pumping and treatment facilities will eventually be required to provide for the predicted future maximum 24-hr pumpage of 10 mil gal and the anticipated peak demand rate of 15 mgd. Construction of the ground storage reservoir is only the first phase of this program.

Ground storage has already done more to correct the unsatisfactory conditions that first prompted this study than could have been accomplished with any of the other needed improvements.

Reference

1. *Standard Schedule for Grading Cities and Towns of the United States.* Natl. Board of Fire Underwriters, New York (1942); *Jour. AWWA,* **34**: *following p.* 1584 (Oct. 1942).

Expansion Joints in Concrete Reservoir Floors

By Leslie A. Hosegood

A paper presented on Oct. 29, 1953, at the California Section Meeting, San Francisco, Calif., by Leslie A. Hosegood, Supt. & Chief Engr., Munic. Water Dept., San Bernardino, Calif.

RESERVOIR design is a subject of great importance to water works engineers, because it is their responsibility to develop and construct adequate systems to meet the full requirements of the population served. An adequate system includes the structures necessary to secure, store, and distribute water, all three phases being equally essential.

In order to meet growing demands, many cities are continually faced with the problem of acquiring additional reservoir capacity. Consequently, a discussion of any phase of reservoir construction should be of interest. One important feature in reinforced concrete structures is the design and installation of construction and expansion joints.

A well designed, properly constructed joint serves three purposes: [1] it provides for movement without overstressing the adjoining parts of the structure; [2] it is helpful in the placing of the concrete in accordance with a prearranged working schedule; and [3] it provides watertightness by generally eliminating cracks due to the expansion and contraction of the concrete. The desirable characteristics of a joint include ease of construction and protection of the material used as a diaphragm. The design must also make it possible to place the concrete adjacent to the joint in a compact mass, free from any voids.

Types of Joint

At the outset, it is necessary to understand the difference between a construction and an expansion joint. It is commonly understood that, in a construction joint, the reinforcing steel is continuous, so that the stresses within the structure are carried through the joint. In a true expansion-and-contraction joint there is no such bond, each section being free to adjust itself to any movement that may occur. It is interesting to note that, in similar types of reservoir design, engineers will use both types of construction. In reservoir floors, however, the expansion joint is generally used when the design of the reservoir permits.*

Many years ago it was quite common practice to eliminate construction joints as much as possible and to employ no expansion joints at all, the structure being allowed to expand or contract where it might. After a short period of operation, the reservoir was dewatered and the fractures repaired with a mastic type of material. The concrete adjacent to the crack was

* The experience of some engineers has pointed to the avoidance of expansion joints in favor of adequate temperature reinforcing, tying the reservoir together with sufficient steel to reduce cracking to a minimum.—*Ed.*

chipped out approximately 1 in. in width and 2 in. in depth, forming a V. After a thorough cleaning, a special priming paint was applied to the sides of the V and to the concrete floor approximately 12 in. on each side of the crack. When dry, the joint was filled with a fibrous mastic material, which was held in place by using an 8-in. and a 10-in. burlap membrane thoroughly bonded to the concrete with hot coal-tar pitch (Fig. 1). This method proved very satisfactory in crack repair and was used with equal success in a constructed joint.

It is logical to assume that, if provision is made for expansion to take place within a predetermined area, fractures will not develop elsewhere. In a square or rectangular reservoir, the floor is laid out in sections of uniform areas. If the column spacing is 20 ft between centers, these sections are normally 40 ft square. Some engineers prefer a 20-ft square section. On the other hand, several years ago, San Bernardino, Calif., built a 10-mil gal distribution storage reservoir in which 60-ft square floor sections were used without difficulty. The author would

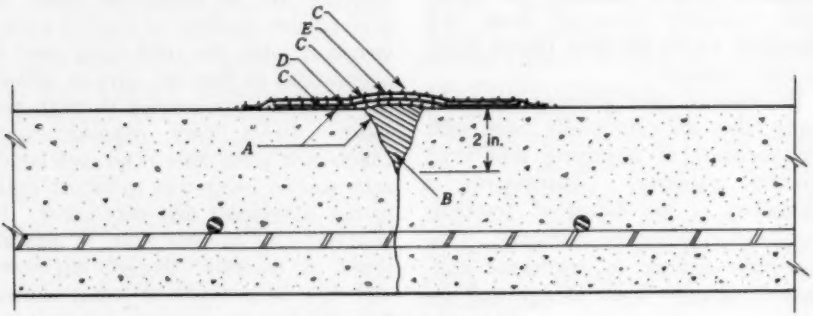

Fig. 1. Repair Joint

A—*primer;* B—*mastic;* C—*coal-tar pitch;* D—*8-in. burlap membrane;* E—*10-in. burlap membrane.*

There is no doubt that the present practice of installing a system of joints throughout the floor of the reservoir is the proper solution. All monolithic concrete structures are vulnerable to cracking from concrete shrinkage during curing or as the result of temperature changes or unequal settlement. In many structures, such cracking is merely unsightly and not serious, but control of all cracks in hydraulic installations is of paramount importance.

recommend, however, that the floor sections should not be larger than 40 ft square, in order to insure good construction.

Most engineers now specify a dam or water stop in all expansion or construction joints. The many different types of materials used for this purpose include galvanized iron, steel plate, strips of soft wood, sheet copper, rubber, plastic, or fabric impregnated with asphalt or pitch. Whatever the mate-

rial, it should be resistant to attack by the water and must not be ruptured by the small movements that may occur in the joint. Copper, rubber, and plastic compounds are most popular today.

Copper Stop

The copper stop is constructed from a strip of 16-oz, hot-rolled, soft copper approximately 16 in. in width. The edges of the strip are crimped back $\frac{1}{2}$ in. for stiffening, and a strip 3 in. wide is turned at right angles on each side to form a channel section. Expansion or contraction is provided for by bending the metal at the center into an inverted U, which is filled with mastic to keep out the concrete (Fig. 2). Where a floor section joins the wall footing, only the side of the copper strip away from the wall is turned up.

The only objection to the use of copper is its softness. It is easily damaged by a careless worker, particularly in removing the form header. Such damage can be repaired by solder, but there is always the possibility that a hole made in the stop will not be found by the inspector.

San Bernardino has used a copper water stop, combined with a bituminous-rubber compound employed as a surface sealer. During the finishing of the secondary slab, a wedge-shaped piece of wood is driven into the wet concrete adjacent to the initial slab. After the concrete has hardened, the stripping is easily removed, leaving a notch into which the heated rubberized asphalt is easily poured (Fig. 3). This material, manufactured under a uniform specification by several different companies, adheres to the concrete very tenaciously and requires no priming. It has been used as a joint filler without any water stop in reservoirs with low hydrostatic heads. Together with a metal or rubber stop, it gives

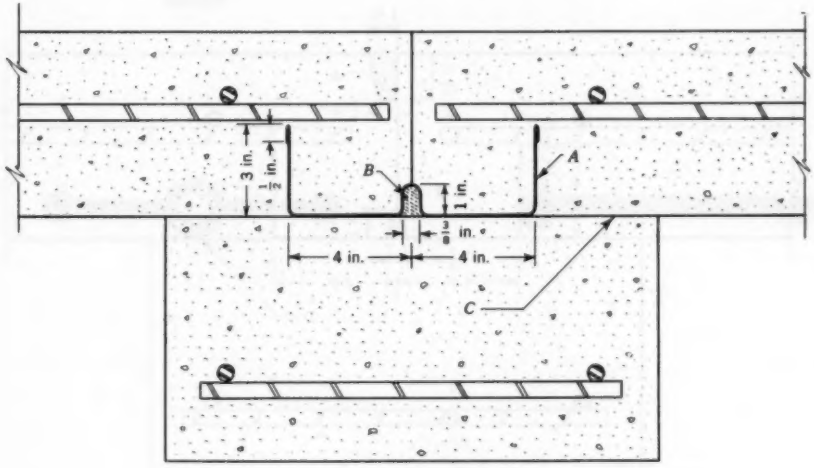

Fig. 2. Copper Water Stop

A—*copper strip;* B—*mastic;* C—*paint to prevent bond.*

added assurance of absolute watertightness.

Rubber Stop

The US Bureau of Reclamation first used rubber water stops in 1936, for Imperial Dam on the Colorado River and the All-American Canal. Since that time there has been a great deal of development in this field. In recent years rubber stops have been used extensively in water storage reservoirs, and they are now available commercially in a number of forms (Fig. 4). All the different designs utilize the principle of embedding half the width (total width 6 or 9 in.) in the monolithic concrete on each side of the joint, so that the rubber spans the joint, forming a water seal. Each type has side bulbs of greater dimension than the web thickness. When embedded in the concrete, the bulbs resist any tendency of the water stop to be pulled out of the concrete if the joint opens. Any contraction or expansion of the joint exerts a pressure between the side bulbs and the concrete, which increases the resistance to water percolating around the stop.

Hollow-center bulbs are incorporated in Type *A–E* seals to provide maximum flexibility and to reduce shearing stresses in the seals when deformed transversely. Type *F* and *G* seals are designed with straight, uniform-thickness webs between the side bulbs for sealing straight expansion joints where no shear movement between adjoining sections of concrete is anticipated. Type *G* is the seal normally used in reservoir construction (see Fig. 5). It can be purchased in any desired length, but, from the standpoint of weight and bulk, the maximum length that can be readily

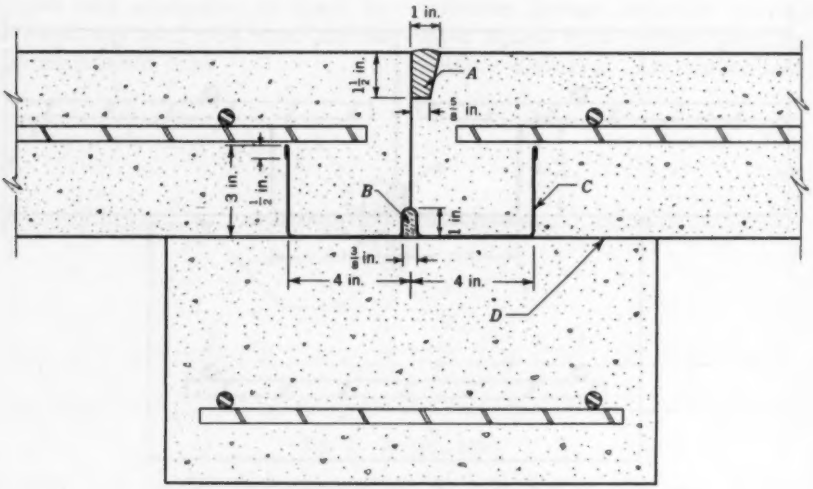

Fig. 3. Copper and Rubberized Asphalt

A—*rubberized asphalt (no primer required)*; B—*mastic;* C—*copper strip;* D—*paint to prevent bond.*

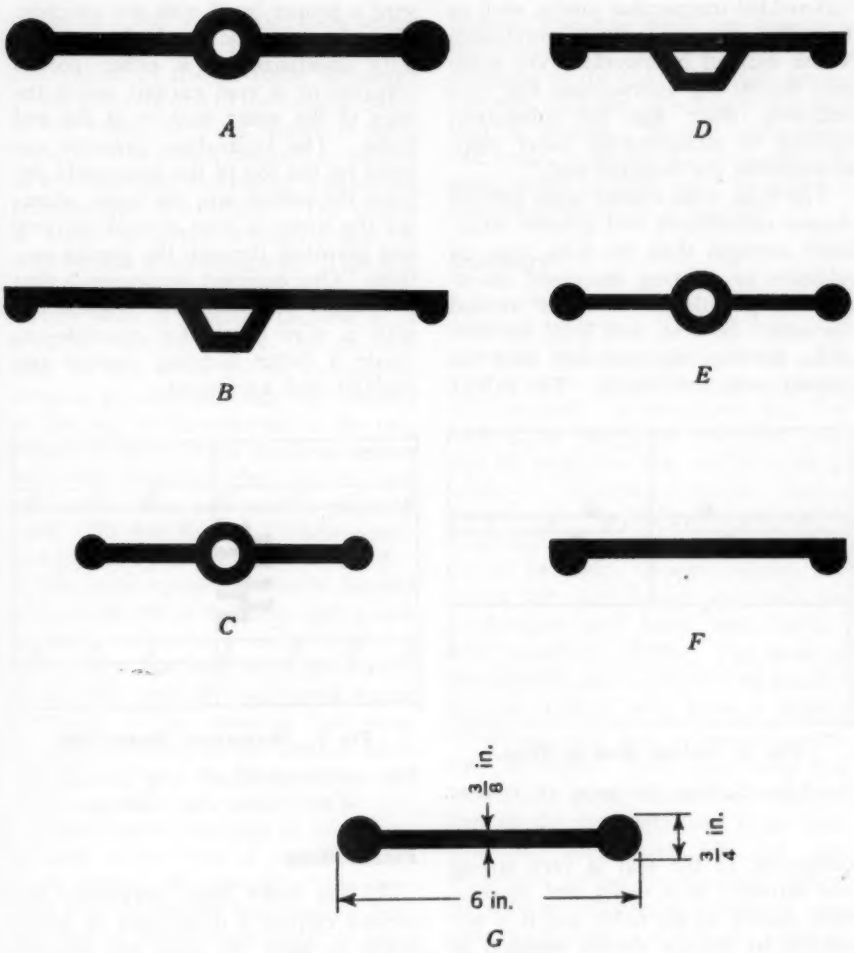

Fig. 4. Rubber Water Stops

Type G is normally used in reservoir construction.

handled during installation is approximately 100 ft. It can be joined together in the field by cold-cemented lap splices or by molded vulcanized splices. The latter are more commonly employed and are easily made with small, portable, electrically heated vulcanizing units using 110-v a-c current. The flat sides on Type *B*, *D*, and *F* seals facilitate the making of field joints.

Reservoir floors require both longitudinal and transverse joints, and provision for a water seal at these joint intersections can be made in two ways. The intersecting pieces of water stop can be lapped and cold cemented, or

full-molded intersection pieces, such as tees, ells, or crosses, can be purchased. These molded intersections are made only for 90-deg intersections and have relatively short legs for subsequent splicing to straight-strip water stops to complete the required seal.

The 9-in. wide rubber seals provide deeper embedment and greater structural strength than the 6-in. type, in addition to offering increased resistance to percolation of water around the seal. In 6-in. and 8-in. concrete slabs, the 6-in. seal normally used has proved very satisfactory. The rubber compound in the seal is very strong and durable; it is easily and successfully spliced in the field; and it is not subject to damage during removal of the form headers. The rubber seal is also recommended for use in circular reservoirs, as it will easily bend to fit a joint between the floor and wall sections. Laboratory pullout tests on Type *A* stops indicate that loads of 390 lb per lineal inch of seal are necessary to pull these seals out of their embedment.

The only objection to the use of rubber is that its smoothness may prevent a proper bond with the concrete. This characteristic would be particularly unsatisfactory if either porous concrete or a void existed under the edge of the water stop or at the end bulbs. The hydrostatic pressure exerted on the top of the dam could depress the rubber into the voids, allowing the water to pass around the stop and percolate through the porous sections. One engineer recommends that the rubber membrane be roughened—with a wire brush, for example—to create a better bonding surface and prohibit such movement.

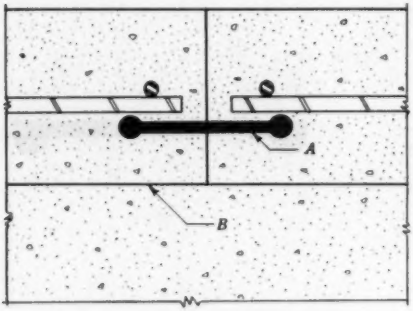

Fig. 5. Rubber Stop in Place

A—*Type G stop;* B—*paint to prevent bond.*

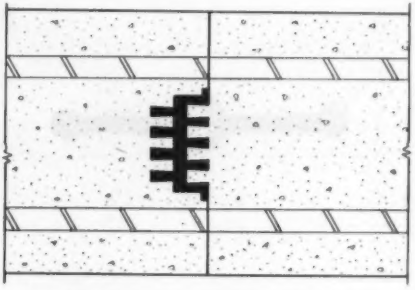

Fig. 6. "Labyrinth" Water Stop

This polyvinyl plastic stop is made by Water Seals, Inc., Chicago.

Plastic Stop

All the water stops previously described employ a diaphragm or membrane to span the joint and provide resistance to the flow of water. A polyvinyl plastic stop now on the market appears to have largely eliminated the objectionable features and expensive construction characteristic of diaphragms. Discarding the principle that a water stop must necessarily be a diaphragm transverse to the joint, the plastic stop lies within the joint itself and is so designed that it forces the seepage to follow a tortuous path

(Fig. 6). For water reservoirs where the only movement is that of separation caused by the inevitable shrinkage of the concrete due to the cooling effect of the water, a ribbed design is used. In structures where the joint is subject to a differential movement, a three-rib cellular type is available. The device is simple to install in either a floor or wall section of the reservoir. The stop cannot be damaged before the secondary slab is poured, because it is actually recessed within the primary slab, so that there are no protruding sections to interfere with the forming or placing of the concrete in the secondary section. After the form header has been installed, the stop is laid against the form and held in place by nails. No split forms or other expensive carpentry is needed.

The stop comes in 100-ft lengths and can be cut in the field with a saw or knife. It is very easily fused by means of a hot knife or a blowtorch, no special welding equipment being necessary. The material has been thoroughly tested at the Denver laboratories of the US Dept. of the Interior.

Regardless of the type of joint constructed or the type of material used in its design, the placing of the concrete is of the utmost importance. Unless care is taken, particularly in handling the concrete in the secondary slab, difficulties will be encountered. Sloping reservoir walls are especially hazardous, as vibration will cause slumping of the concrete. Any porous concrete adjacent to a water stop will lead to trouble. Proper precautions and close inspection are required and good, dense concrete must be used if a watertight reservoir is desired.

Summary

It is recommended that all reinforced concrete reservoirs be built with construction and expansion joints. The floor sections should be approximately 40 ft square. In structures with low hydrostatic heads, an excellent joint can be made by the use of coal-tar pitch or bituminous-rubber sealing compounds. In reservoirs subject to relatively high water pressures, a seal should be used. Copper, rubber, and plastic are satisfactory materials for diaphragms and have been utilized with excellent results. For ease of construction and avoidance of possible damage, rubber seals have a definite advantage over soft annealed copper, the "labyrinth" water stop being best of all. No joint, regardless of its design or the materials used in its construction, will prove 100 per cent watertight unless the greatest care is taken to insure proper placing of concrete, so that there will be no voids or porous concrete adjacent to the expansion joint.

Maintaining Well Production by Chemical Cleaning

By Gordon L. E. Linn

A paper presented on Oct. 23, 1953, at the New Jersey Section Meeting, Atlantic City, N.J., by Gordon L. E. Linn, Mgr., Duhernal Water System, Parlin, N.J.

THE Duhernal Water System, organized in 1939, operates 20 gravel-packed wells varying in productivity from 350 to 2,000 gpm. Eighteen of the wells, in Old Bridge Sand, are 80–100 ft deep, and two wells, in Farrington Sand, are about 300 ft deep. Both water-bearing sands are members of the Raritan formation of the Upper Cretaceous Age. The well field is located near an artificial lake on the headwaters of the South River in New Jersey. The present firm capacity of the system is 16 mgd, with frequent hourly peaks of 20 mgd. In order to meet the water demand, the cleaning of wells and connecting pipelines becomes an important routine job.

The two wells in Farrington Sand produce as much water now as when drilled and do not require any cleaning. Owing to a serious salt water intrusion problem, however, they are operated only when absolutely necessary. Two of the wells in Old Bridge Sand were recently placed in service and do not yet need cleaning. Another has been operating almost continuously for 14 years, and was cleaned only once, in January 1952, when the pump was reconditioned. The productivity at that time was increased only 19 gpm (from 456 to 475 gpm). This well and another installed in 1947 maintain almost constant production, varying only slightly with the ground water level. They are not contaminated by any bacteria and there are no large deposits in the pump, pump columns, or discharge lines. The other fourteen wells in Old Bridge Sand require periodic cleaning for reasonable productivity.

The cleaning program at Duhernal is conducted in three phases: [1] chemical cleaning of the sand stratum and gravel pack around the well screen; [2] chemical cleaning of the well screen, pump, and pump discharge column; and [3] mechanical cleaning of the connecting pipelines and the distribution system. The frequency with which any part of the well system is cleaned affects the overall productivity. A well in which the sand and the gravel pack are clean may be able to deliver more water than a pump fouled by bacterial growths or other deposits can handle. When the pump is clean and the sand stratum is clogged, the productivity will also be less than normal. Even if the well and pump are clean, fouled connecting pipelines will lower production owing to increased back pressure. Therefore, for a well to maintain reasonable production, it lower production, owing to increased is necessary that all parts of the system be cleaned according to schedule. The rate of decrease in production determines the frequency of cleaning, which may vary from once a year for some

TABLE 1

Well and Pump Cleaning Program

Well No.	Chemicals Used*		Normal Interval Between Cleanings wk	Original Capacity gpm
	Sand	Pump		
		Group *A*		
3	H_2SO_4, HCl, PO_4	H_2SO_4, HCl	26	656
4	H_2SO_4, PO_4	H_2SO_4	52	700
5	H_2SO_4, HCl, PO_4	H_2SO_4, HCl	10	567
6	H_2SO_4, HCl, PO_4	H_2SO_4, HCl	10	630
14	H_2SO_4, HCl, PO_4	H_2SO_4, HCl	10	880
15	H_2SO_4, PO_4	H_2SO_4	10	725
16	H_2SO_4, PO_4	H_2SO_4	20	730
		Group *B*		
1	H_2SO_4	H_2SO_4	52	640
2	H_2SO_4	H_2SO_4	52	650
17	H_2SO_4	H_2SO_4	52	700
18	H_2SO_4, HCl	H_2SO_4, HCl	20	700
10	H_2SO_4	H_2SO_4	52	1,400
11	H_2SO_4	H_2SO_4	52	1,210
12	H_2SO_4	H_2SO_4	75	1,030
		Group *C*		
8	no cleaning required			455
13				1,020
A.F.				1,350
B.F.				1,840

* H_2SO_4—inhibited sulfuric acid; normal amount used per well, 45 gal. HCl—inhibited hydrochloric acid; normal amount used per well, 90 gal. (The acids used are products of E. I. du Pont de Nemours & Co., Wilmington, Del.) PO_4—phosphate; normal amount used per well, 50–75 lb.

wells to as often as once in 2 months or less for others. It is a disheartening fact that every part gets dirty again shortly after being cleaned.

Each of the Duhernal wells is equipped with flow and pressure meters, and the productivity is checked daily. Capacity tests of wells under standard pressure conditions are made periodically, to determine the need for cleaning and to measure the effectiveness of any cleaning program.

The eighteen Old Bridge Sand wells fall into three groups, according to their cleaning requirements. The well and pump cleaning program is outlined in Table 1 and described in detail below. Group *C* wells do not require cleaning, all decreases in production being traceable to lowered ground waters levels or pump wear.

Sand and Gravel Cleaning

It is believed that the principal plugging material in the sand strata and the gravel pack around the wells in Group *A* is clay, a common situation in shallow wells along the Atlantic seaboard. As the sands are about 40,000,-000 years old, it may be wondered why

the sand did not become plugged with clay during the long period before pumping started. The answer to this question must be the reduced rate of movement of water through the sand. It is known that, at times, a well will produce clay-colored water at a high rate of pumpage and relatively clear water at a low rate.

Clays are in their most dehydrated form in an acid environment. This probably explains why, when some wells are treated with acid, there is no increase in production even though large quantities of deposits are removed. In general, wells drilled in rather clean sand do not plug readily.

The cleaning of the sand stratum around each well in Group *A* consists of deflocculating and dispersing the clay particles from the sand and gravel and subsequently removing them from the well by pumping to waste. On some wells, frequent cleaning with small doses of chemicals is more effective than fewer cleanings with larger doses. It is believed that much of the clay in the sand around a well is deposited by mechanical filtration, as ordinary backflushing or surging will frequently remove a large portion of this material. It is often stated that resting or rotation of wells tends to maintain or improve production by changing the flow pattern through the sand and perhaps releasing the deposits in the formation so that they are removed when the well is placed in service again.

The clogging of sand and gravel may also be due to the cementing action of iron deposits when the pumping level in the well is consistently below the top of the screen. Recent cleanings at Duhernal indicate that a combination of 25 lb of sodium hydrosulfite, a reducing agent, with 50 lb of tetrasodium pyrophosphate is more effective than phosphate alone. Occasionally, inhibited sulfuric and hydrochloric acid are also used, depending on the results of the phosphate cleaning and the color of the waste water.

The sand and gravel around the wells in Group *B* are cleaned with inhibited sulfuric or hydrochloric acid and sometimes phosphate. The cleaning of the sand strata of the wells in either group is the most tedious phase of the operation.

Screen and Pump Cleaning

The well screen, pump, pump discharge column, and connecting pipelines require periodic cleaning, mainly to remove bacterial growths. The type of bacteria most common at Duhernal is *Gallionella ferruginea*, or a similar organism, which feeds on ferrous iron and has a very rapid growth. For example, inside a pipeline, it will grow into a mass as thick as 1 in. in about 10 weeks. It will reach greater thickness on the long-radius side of an elbow than on the short-radius side, because more water—and, hence, more food—passes the former. This accumulation may be described as a soft, brick-red slime consisting of iron oxide and dead bacteria, held together by a matrix of live, threadlike organisms. The deposit is easily wiped off the pipe with the hand. A typical analysis of this deposit is given in Table 2.

The rippled surface of the deposits causes eddy currents on the periphery of the water passing through the pipe, so that the friction coefficient is lower than it would be for an equivalent thickness of smooth-surfaced scale; hence the need for frequent pipeline cleaning. It is interesting to note that an adjacent well field at Runyon, N.J., is not troubled with bacterial growths.

The water there is removed by suction and then lime treated and filtered to extract the iron. It is evident that the iron bacteria will not grow under a partial vacuum and, of course, will not live after the iron has been removed from the water and the pH raised.

The cleaning of the screen, pump, and pump column is usually accomplished with inhibited sulfuric acid, which dissolves the bacterial growths and, after 24 or 48 hr, may be pumped to waste. If the deposit is a hard scale, inhibited hydrochloric acid is used, and sometimes a mixture of both is employed, in order to take advantage of the heat generated. A small sample of the deposit placed in glass beakers with different acids readily shows which acid will dissolve or disperse it. Of course, it is possible to clean the screen, pump, and pump column mechanically, by removing the pump from the well, but such a method costs about $1,000, approximately ten times the price of chemical cleaning. Moreover, with mechanical cleaning, the well is out of service for a longer period than with chemical cleaning.

TABLE 2

Slime Deposit Analysis

Item	Amount *per cent*
Fe, Al, P (as Fe_2O_3)	56.16
Total Fe (as Fe_2O_3)	48.31
Moisture (loss at 105°C)	8.79
Total loss on ignition (organic matter plus moisture)	27.60
Silica (as SiO_2)	10.17
Qualitative Tests	
Co_3, SO_4, Cl, Ca	no
PO_4, Mg	yes

In addition to the two acids previously mentioned, the list of chemicals that have been used to clean Duhernal wells includes: sodium hexametaphosphate, adjusted to pH 8.0 with sodium silicate or sodium carbonate; a commercial mixture of hydrochloric acid, ammonium bifluoride, and a wetting agent; calcium chloride; chlorine; various synthetic detergents (used with phosphates); sodium hydrosulfite (used with phosphates); sodium tripolyphosphate; and tetrasodium pyrophosphate. The effectiveness of some of these chemicals has not been completely evaluated.

TABLE 3

Well Water Analysis

Item	Range
pH	4.2–6.2
Phenolphthalein acidity—*ppm*	3.3–132
Methyl purple alkalinity—*ppm*	0–15
Sulfates—*ppm*	11–50
Iron—*ppm*	2.4–24
Hardness (soap test)—*ppm*	8.8–17

There appears to be no relationship between the chemical composition of the water and the need for cleaning the wells. It is suspected, however, that the necessity for cleaning the pumps and pipelines is affected by the total water pumped, because the more iron furnished the bacteria, the faster the growth. Table 3 shows the range in concentration of various chemicals in Old Bridge Sand well water during 1952.

Chemical Cleaning Method

The wells have aboveground discharge lines with 2-in. nipples welded at the top for air release valves. The valve is replaced by a steel funnel through which the chemicals are poured into the discharge piping. The chemi-

cals flow backward down the pump discharge column, through the pump, and into the well. The discharge check valves have bypass lines with stop valves. If the chemical is to be used for cleaning the sand, the bypass line valve is opened to waste and the discharge line backflushed. Then the waste valve is closed, and water from the system goes down the pump column

Fig. 1. Mechanical Pipeline Cleaner

The Duhernal-designed, rubber-covered arms of the cleaner wipe off the slime deposits with a squeegee action.

and forces the chemicals out into the sand formation. The farther the sand to be cleaned is from the screen, the more backwash water is required.

After each treatment, the well capacity is tested under standard conditions of pressure and flow. When there is no more improvement in capacity or when it is back to normal, the treatments are stopped. Sometimes, even after frequent chemical treatments, the capacity of the well is less than at the start. It is then assumed that the formation has become plugged again near the screen.

In one instance, four 2½-in. injection wells with 3-ft screens, at various depths in the sand stratum, were equally spaced about 10 ft from the center of a well to be cleaned. Various chemicals were poured into the injection wells and spread by pumping air and water. This method was abandoned because it was not found much more effective than treating the well from the inside through the screen.

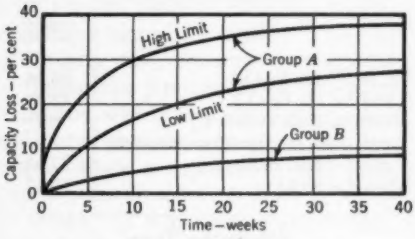

Fig. 2. Rate of Capacity Loss

The seven Group A *wells are affected by clay and iron deposits. The seven Group* B *wells are affected by iron deposits only.*

On another occasion, a pailful of sand and fine gravel was poured slowly down the inside casing of a well, while the pump was discharging to waste, in the hope that the deposits would be removed mechanically from the pump and pump column. The results were not sufficiently satisfactory to warrant taking a chance on cutting the pump impellers and bearings.

From the water level in observation wells sunk in the gravel pack and within 10 ft of the center of the producing well, it is possible to determine when the sand formation is plugged and how effective the chemical treat-

ment is. When it is decided that the maximum amount of water is entering the well and that the sand stratum is clean, the pump is tested against its characteristic curve. If the pump and discharge column need cleaning, inhibited sulfuric acid is poured into the discharge piping in the manner previously described, but without any backwash water, so as to hold the acid in the pump. If this acid is not completely successful, inhibited hydrochloric acid is used, and sometimes a combination of both is employed.

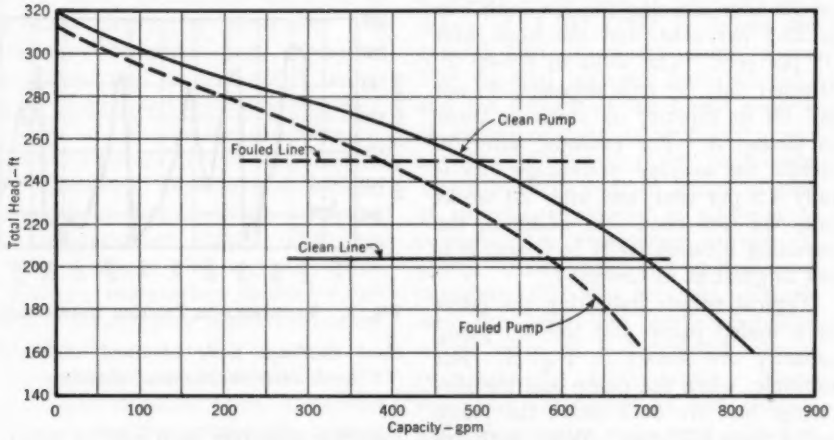

Fig. 3. Effect of Fouled Pump and Line on Pump Capacity

A fouled pump and discharge line will suffer a capacity loss of more than 300 gpm.

Pipeline Cleaning

Pipelines fouled by bacterial growths are cleaned mechanically about every 10 weeks, the interval depending on the quantity of water passing through the lines. During high-flow periods, as in the summer, the amount of water and bacterial food is greater than in low-flow periods.

Chain-covered rubber ball cleaners are used on short lengths of 6–24-in. pipe. Some of the chains are covered with sections of rubber hose to protect the asbestos-cement pipe. Occasionally two ball cleaners are utilized, one with water and the other with air. The former insures the cleaning of the bottom of the pipe.

Two cleaning machines, one for 18-in. and one for 30-in. pipe, are also employed. They are made in sections, to permit going around an elbow, and the flat, rubber-covered pieces which move along the pipe are spring loaded. The squeegee action of the rubber-covered arms easily wipes off the deposit, while the driving water behind the cleaner flushes out the dirty water through blowoff connections located at low points along the line. Access boxes have been installed to allow the cleaners to be inserted in the mechanically coupled pipelines. The 18-in. cleaner travels approximately 14,000 ft, and the 30-in. cleaner 29,000 ft between access boxes. They do an excellent job, often raising the

pipeline friction coefficient to more than 140. A photograph of one of the cleaning machines is shown in Fig. 1.

Effects of Cleaning

Figure 2 shows that the average percentage loss in capacity of the seven Group *A* wells, affected by clay and iron deposits, falls between a low and a high limit. Ten weeks after cleaning there is a 16.5 per cent loss in the capacity of some of the wells and as much as 30 per cent in others. Twenty weeks after cleaning the low-limit loss is 22.5 per cent, and the high limit 35 per cent. The wells in Group *B*, affected only by iron deposits, do not fall off in capacity as much as those in Group *A*. For example, after 10 weeks, the average percentage loss is only 4.5 per cent, and after 20 weeks only 6.5 per cent. In addition, the variation between wells in Group *B* is not as great as in Group *A*.

Typical curves indicating the effect of a fouled pump and line on pump capacity are shown in Fig. 3. For example, when the pump and the discharge line are both clean, the pump will deliver 700 gpm. When both are dirty, the pump will deliver only 390 gpm. If the pump is clean and the pipeline dirty, 500 gpm will be delivered, and if the pump is dirty and the pipeline clean, 585 gpm.

Figure 4 shows the weekly variations in friction coefficients on a typical section of distribution pipeline. The peak readings were obtained within a week after mechanical cleaning. The coefficients fall off rapidly shortly after cleaning, dropping from a high of approximately 150 to a low of approximately 95.

Conclusion

Chemical cleaning at Duhernal is still in more or less of an experimental stage, although it has been practiced for about 10 years. Tests with different kinds of chemicals are being conducted regularly, using various methods and quantities. Experience has shown that there is no easy cleaning method and that no treatment of any type is successful in improving production every time. Well cleaning demands a relatively high level of supervision, ingenuity, and patience to get the best results. Frequently a well requires several treatments before any improvement is noted, although, on occasion, one treatment may give the maximum improvement possible.

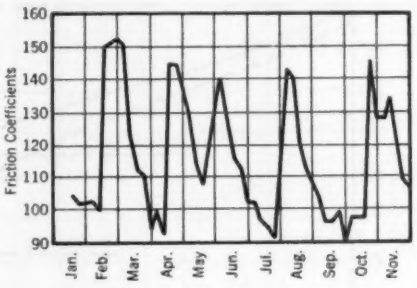

Fig. 4. Variations in Friction Coefficients

Peak readings were obtained within a week after mechanical cleaning.

Without any cleaning, at Duhernal, it would be necessary to install six new wells and 10 miles of duplicate pipelines, at a cost of perhaps $1,000,000. Chemical and mechanical cleaning, therefore, is not only economical and practical but necessary to maintain reasonable well productivity.

Contamination of Ground Water by Cadmium

By Maxim Lieber and W. Fred Welsch

A paper presented on Apr. 22, 1954, at the New York Section Meeting, Watertown, N.Y., by Maxim Lieber, Assoc. San. Chemist, Div. of Labs. & Research, Nassau County Dept. of Health, Hempstead, N.Y., and W. Fred Welsch, Sr. Engr., Div. of Sanitation & Water Supply, Nassau County Dept. of Public Works, Mineola, N.Y.

THE heavy metals are employed in many industrial processes. In particular, cadmium and chromium are widely used in the aircraft industry for plating and anodizing purposes, in order to enhance the corrosion resistance of aluminum and other metals. The counties of Nassau and Suffolk, Long Island, N.Y., include numerous aircraft production plants. This area possesses unique characteristics from a sanitary engineering viewpoint because of its complete dependence upon ground water as a source of supply.

The average annual rainfall in the area is approximately 42 in. Less than half seeps into the ground, the balance being lost through evaporation, transpiration, and stream runoff into tidal waters. To maintain the ground water supply at a maximum, large impounding and artificial-recharge basins are located throughout the region. These basins, which vary in size from 2 to 9 acres, permit a large percentage of the storm drainage to percolate into the ground water aquifers.

Geologically, Long Island is underlain by bedrock, consisting of schists and gneisses. In Nassau County, the rock foundation is approximately 400 ft below the north shoreline, sloping gently, at a rate of 64 ft to the mile, in a general southeasterly direction to a depth of 1,500–2,000 ft below the ground surface on the south shore. The material between this rock floor and the surface of the island consists of successive layers of sand and gravel aquifers of considerable magnitude. These aquifers contain lenses of clay of variable thickness, in addition to possessing a tremendous storage capacity. Rain water and melted snow percolate through pervious subsoils into the sand and gravel aquifers, which serve as underground storage reservoirs for fresh water. These reservoirs are tapped by both shallow and deep artesian wells for public, private, industrial, and agricultural water supplies. Filtration through the type of soil structure described unfortunately does not appreciably reduce the concentration of many chemical contaminants in the water.

Industrial plants dispose of their wastes through recharge basins, diffusion wells, and, if permitted, sanitary sewerage systems. During World War II the quantity of hexavalent chromium wastes, disposed of by recharging, contaminated large segments of the ground water reservoirs before deleterious effects were detected. An investigation previously reported (*1*)

disclosed that deep public wells and shallow private wells were contaminated with this substance. The industrial plants responsible are now required to remove chromium from their wastes before disposal into the recharge basins. The degradation of water quality that has already occurred, however, can be repaired only by time. It is estimated that many years will have to elapse before the effects of dilution and ground water flow will improve this condition.

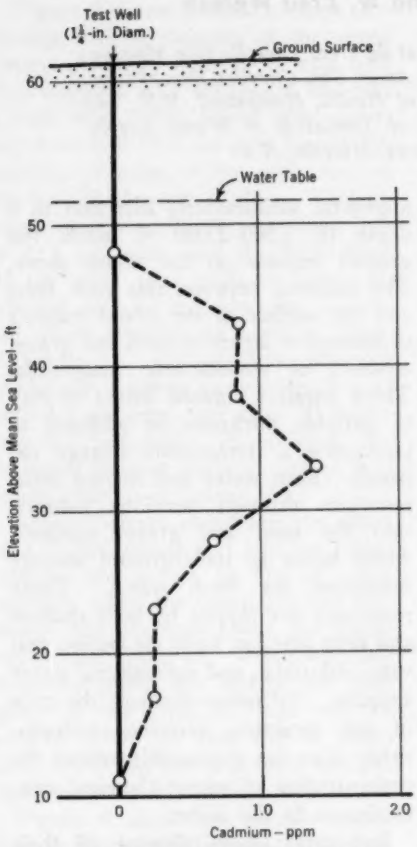

Fig. 1. Typical Test Well Results

The graph shows the cadmium concentration at various depths in Well No. 2 (see Fig. 2 for location).

A continuation of the study revealed the presence of cadmium, a heavier and presumably more toxic metal than chromium in the ground water. Cadmium is utilized on a large scale in industrial plating operations. An analysis of the water in a recharge basin at an aircraft company established the presence of 1.2 ppm of cadmium. A survey conducted on private shallow wells in the area disclosed that two of them, in operation at the time of the investigation, contained 0.6 ppm and 0.34 ppm cadmium, respectively.

A dithizone extraction method was used to determine the cadmium in the waters analyzed.* Because of the difficulties and interferences normally encountered in this procedure, a duplicate sample of one of the private well waters containing cadmium was submitted to the Div. of Labs. and Research of the New York State Dept. of Health, which confirmed the original findings.

Test Well Program

Using the experience gained in previous studies of ground water contamination by chromium, the Nassau County health and sanitation agencies initiated a thorough investigation program on cadmium pollution. Several series of test wells were drilled on lines perpendicular to the direction of ground water flow, just south of the recharge basins in question. An attempt was made to determine the width

* *Standard Methods* (2) does not include a cadmium determination procedure.

of the contaminated water strata, the depths at which the cadmium was located, and the horizontal course along which this contaminant was being carried by the natural ground water flow.

The wells were sunk by dropping a 200-lb guided weight on top of 5-ft coupled sections of 1¼-in. diameter, extraheavy drive pipe, the lowest section of which had a standard wellpoint attached to the bottom. By means of a pitcher type hand pump, water samples were taken at 5-ft intervals to an average depth of approximately 50 ft. In several instances, attempts were made to continue the well-driving operation until a sample was obtained in which the contaminant was not detected. By following this procedure, it was possible to determine both the vertical distribution and the elevation of maximum cadmium concentration.

Figure 1 is a graphic illustration of a typical test well (Well No. 2). It will be noted that a variation in cadmium concentration existed at different elevations, the maximum (1.4 ppm) occurring at el 33.19 and the minimum (less than 0.01 ppm) at the highest and lowest elevations of the well. Table 1 is a consolidation of the data on all of the driven test wells.

The location of these wells is shown in Fig. 2. The suspected origin of the

TABLE 1

Test Well Data

Well No.	Well Depth* ft	Depth to Water Table ft	First Cd Contact		Max. Cd Contact		Last Cd Contact	
			Depth ft	Conc. ppm	Depth ft	Conc. ppm	Depth ft	Conc. ppm
1	55.4	10.0				0.05 –†		
2	50.5	9.7	13.0	0.01 –	28.0	1.40	50.0	0.01 –
3	50.1	11.6	18.0	1.1	31.5	3.20	50.1	1.8
4	50.4	11.6	18.0	0.44	45.0	1.95	50.0	1.3
5	45.1	9.7				0.05 –†		
6	50.5	10.8	13.0	0.05 –	18.0	0.14	29.0	0.05 –
7	50.3	11.0				0.01 –†		
8	58.8	10.2	18.0	0.01 –	49.0	1.92	54.0	0.01 –
9	55.6	11.7	13.0	0.07	34.0	1.30	50.0	0.86
10	44.3	11.2				0.05 –†		
11	55.7	8.2	13.0	0.04	29.0	1.85	50.0	0.01 –
12	50.3	10.0	13.0	0.04	39.0	1.12	50.0	0.26
13	50.1	11.9	18.0	0.01 –	34.0	0.11	44.0	0.01 –
14	49.1	8.9	28.0	0.01 –	38.0	0.10	49.0	0.02 –
15	40.0	11.9				0.01 –†		
16	48.5	10.9	18.0	0.01 –	28.0	0.17	38.0	0.01 –
17	50.2	9.0				0.01 –†		
18	49.6	8.6	13.0	0.05	13.0	0.05	24.0	0.01 –
19	49.3	4.9				0.01 –†		
20	50.5	5.2	18.0	0.01 –	34.0	0.06	39.0	0.01 –
21	48.7	4.6				0.01 –†		
22	49.0	6.4				0.01 –†		

* From ground surface.
† For entire depth.

cadmium is the recharge basins of an industrial plant approximately 700 ft north of the test area. The east and west borders of the contaminated section are roughly parallel, with a slight divergence as the cadmium travels southward under the influence of ground water flow.

The most easterly and westerly test wells along the avenues perpendicular to the direction of ground water flow did not contain significant quantities of cadmium. These borderline wells made it possible to establish the width of the contaminated area. The Lambert Avenue wells (Fig. 3) showed

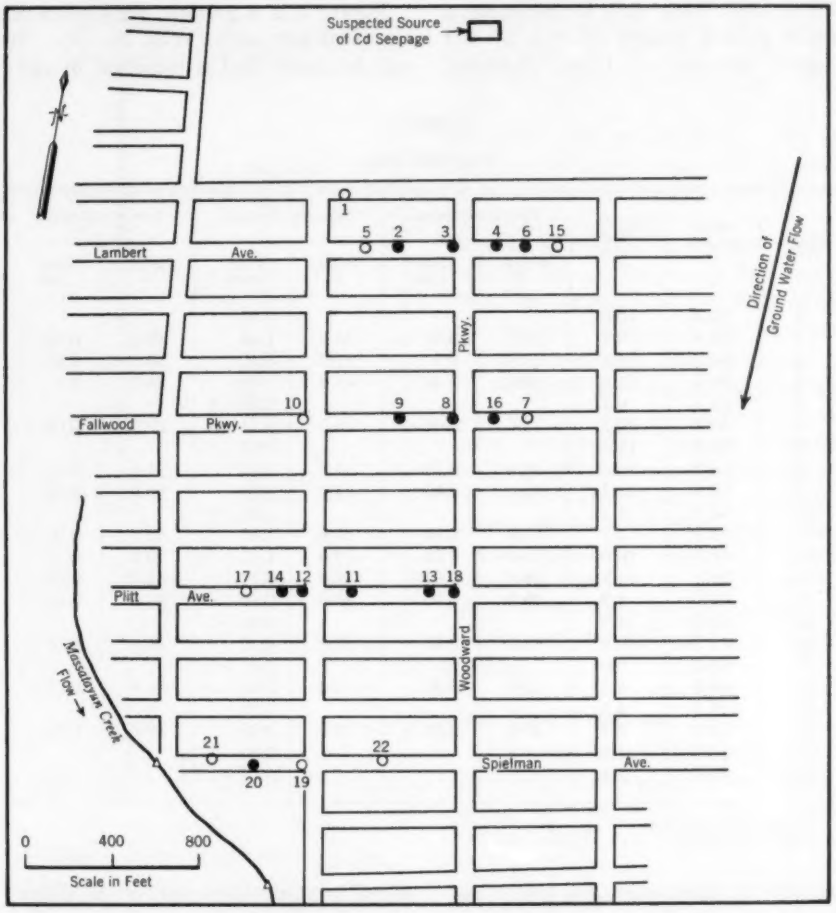

Fig. 2. Location of Test Wells

○ *Less than 0.05 ppm Cd;* ● *more than 0.05 ppm Cd;* △ *stream sample (no Cd).*

the highest concentration of cadmium (3.2 ppm) detected in this investigation. As a result of ground water dilution, the cadmium content gradually decreased in the wells to the south, until, at Spielman Avenue, the element was detected in minute quantities in only one of the driven test wells. No cadmium was found in Massatayun Creek, south of Spielman Avenue, although this surface stream undoubtedly receives some of the ground water flow. The potential hazard to a surface and ground water supply must be considered when contamination is present in the ground water upstream.

To determine the direction of cadmium travel, a longitudinal (north-south) section (Fig. 4) was developed, encompassing the wells with maximum cadmium levels in each of the avenues perpendicular to the ground water flow. It is interesting to note that the indicated direction of longitudinal movement coincides with the findings of previous ground water flow studies (*3*) in the area.

Effects of Cadmium

No instance of cadmium contamination of a drinking-water supply has been found in the literature. The US Public Health Service "Drinking Water Standards" (*4*) make no mention of cadmium as a possible contaminant of drinking water. As the New York State Water Pollution Control Board is guided by these standards, the discovery of this contaminant in drinking water creates the urgent task of establishing a limit for cadmium in potable waters.

Cases of poisoning have been reported involving ingestion of cadmium from food or beverages prepared or stored in cadimum-plated vessels (*5*, *6*). In its physiological effects, cadmium is similar to arsenic and mercury (*7*). Dack (*8*) reported symptoms of violent nausea in 29 school

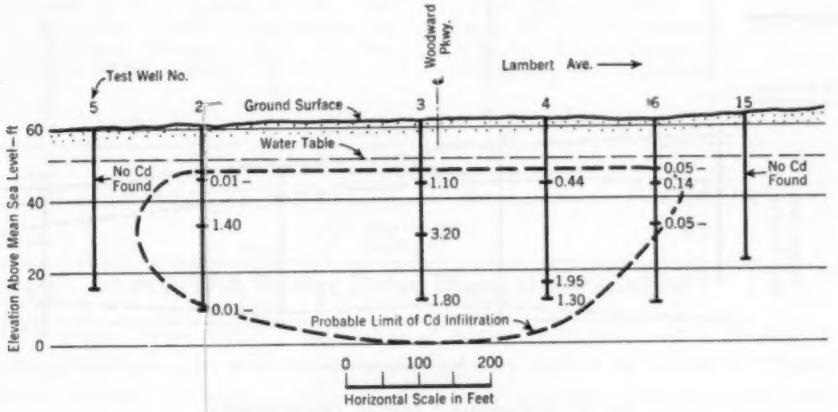

Fig. 3. Lambert Avenue Wells

The numbers within the zone of probable infiltration show the cadmium concentration, in parts per million, at various depths.

children who had consumed fruit ice sticks containing 13–15 ppm of cadmium. As this form of dessert consists of no more than 100–200 ml of liquid in an unfrozen state, it can be inferred that only 1.5–3.0 mg of ingested cadmium would produce the observed toxicological symptoms.

The ground water encountered in the Long Island investigation contained less cadmium than the dosage reported above, but, if they were used both for drinking purposes and for the preparation of food, the quantity ingested would also have to be considered. Some of the ground waters in the present study had cadmium concentrations up to 3.2 ppm. A daily intake of 1 liter of such water would result in the ingestion of an amount of cadmium approaching the toxic quantity mentioned previously. Consequently, it is important to know—but not yet established—whether cadmium is a cumulative poison like lead or mercury. In the present state of knowledge, it appears wise not to regard a drinking water as potable when it contains any cadmium in solution. This opinion is shared by F. W. Gilcreas (*9*), Asst. Director, Div. of Labs. and Research, New York State Dept. of Health, Albany, N.Y.

Conclusions

The discharge of plating wastes into ground waters is creating a hazardous situation in parts of Long Island. Every effort should be made to prohibit such disposal unless the wastes have been treated to remove toxic and deleterious substances.

The appearance of cadmium as a ground water contaminant is unique. It is necessary to ascertain a safe and reasonable limit for cadmium in potable waters, based on additional studies of the physiological effects of the continuous ingestion of minute quantities of the substance. Of equal importance is the establishment of a standard procedure for the chemical analysis of

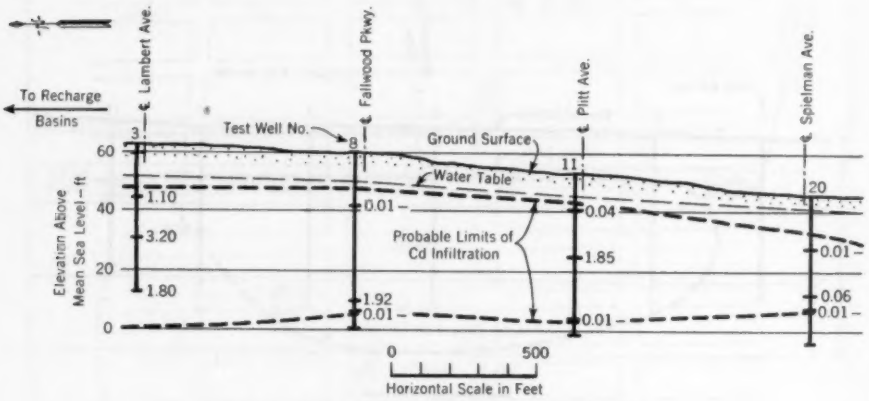

Fig. 4. Longitudinal Section (North-South)

The wells shown are those with the maximum cadmium concentration in each east-west series. The cadmium content at various depths is given in parts per million.

significant quantities of cadmium in waters and trade wastes.

Many years may have to elapse before the effects of rainfall and ground water dilution will eliminate this contaminant from the ground water. It is, however, possible to follow cadmium travel in the ground water. Areas in the direct line of cadmium-contaminated ground water flow are potentially poor locations for wells intended to supply potable water.

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AWWA Water Rates Manual Available

The report of the AWWA Committee on Water Rates published in the March 1954 JOURNAL is now available in reprint form as part of the AWWA "Water Rates Manual." Bound in with the report are generous excerpts from such classic publications on the subject of water rates as the Metcalf, Kuichling, and Hawley paper on fire protection charges and the reports of NEWWA and AWWA committees chairmanned by Allen Hazen, as well as other valuable supplementary material. The 64-page booklet, in stiff paper covers, can be obtained at $1.00 per copy from the American Water Works Assn., Inc., 521 Fifth Avenue, New York 17, N.Y.

Types of Filter Bottoms

By Mark L. Stuppy, Frank C. Roe, Richard Muller, and John R. Hartley

A paper originally presented as a panel discussion on Oct. 30, 1953, at the Chesapeake Section Meeting, Wilmington, Del., by Mark L. Stuppy, Sales Mgr., F. B. Leopold Co., Pittsburgh, Pa.; Frank C. Roe, Sr. Sales Engr., Refractories Div., Carborundum Co., Perth Amboy, N.J.; Richard Muller, Infilco, Inc., Tucson, Ariz.; and John R. Hartley, Vice-Pres., Builders-Providence, Inc., Providence, R.I. The individual discussions were combined into one paper by John E. Vogt, San. Engr., Section of Water Supply, State Dept. of Health, Lansing, Mich.

EFFECTIVE filtration demands that the filtered water be collected at a uniform rate over the entire filter bed and that the wash water be uniformly distributed so as to clean the bed thoroughly. Four filter bottoms used to accomplish these objectives are described in this paper.

Leopold Bottom

The original Leopold design was installed in 1926. Developed by the late F. B. Leopold, it was known as the "Concrete Duplex Filter Bottom." The present-day version, which employs glazed tile instead of concrete, was first used in 1943. This underdrain system is now installed in more than 200 plants having a combined capacity in excess of 1,250 mgd.

The use of a compound block constructed of high-grade, de-aired fire clay, vitrified and salt glazed, assures an installation not subject to corrosion or tuberculation. The fire clay provides a block of far greater strength than standard glazed tile. The loss of head through the block is extremely slight, owing to the large total orifice area and the very low friction coefficient of the material.

In operation, the wash water is applied from a flume in the filter to the lower or lateral portion of the blocks, with the blocks so arranged as to furnish a throughway extending the length or width of the filter. The proportions of the blocks are such that the lateral area of the system is equivalent to the area which would be provided by spacing 5¼-in. pipes 12 in. apart, center to center. This large area effects an even, low-velocity distribution of the wash to all portions of the underdrain system. From the lateral or lower section of the blocks, the wash water rises through 1-in. diameter holes (on approximately 12 in. centers) to the upper or distributing area of the glazed-tile blocks. From this point, the wash water is dispersed upward through the filter bed through $\frac{5}{32}$-in. diameter orifices on 1¼-in. centers, a spacing that provides approximately 45 orifices, or the equivalent of 1 sq in. of orifice area, per square foot of filter area. To give the most uniform wash possible, the upper or distributor portions of each block are segregated from laterally adjacent blocks by glazed-tile joint plates, thereby insuring that the amount of

wash applied to any one block through the 1-in. diameter holes will be dispersed by that block without any possibility of lateral flow in the distributor portion of the system.

The provision of a secondary step in which the underdrain system itself produces complete dispersion of the wash water in the form of multiple jets is probably the most important design characteristic of the Leopold system. As it is not necessary to rely upon the voids between large-size gravel particles for this final dispersion, the gravel is needed only to support the sand filtering medium and prevent its loss through the underdrain system. Consequently, a 6–8-in. bed of small-size gravel is sufficient.

In installation, the 11-in. wide, glazed-tile blocks are set on approximately ½ in. of fresh grout on a flat filter floor. A space of approximately 1 in. between rows of blocks is filled with grout, in order to anchor the blocks and provide a flush bottom surface (Fig. 1). For anchoring the row of blocks over the concrete wash flume of the filter—the only row of blocks subjected to upward thrust by the wash water—Z-shaped ¾-in. steel rods are set in the filter floor on 12-in. centers. The rods are located on both sides of the flume, in the 1-in. space separating the rows of blocks, and are covered with the grout placed between rows. To insure accurate alignment, hardwood dowels are inserted between laterally adjacent blocks at the time of installation. For conventional wash rates, the cross-section area of the flume admitting wash water to the underdrain system should be at least 1½ times the total orifice area.

Fig. 1. Leopold Bottom

The 11-in. wide, glazed-tile blocks are set in fresh grout, with approximately 1 in. of space between rows.

In addition to its widespread use in new plants, the Leopold glazed-tile bottom, owing to its simple installation requirements, is extensively employed in the rehabilitation of existing filter units.

Porous-Plate Bottom

The concept of a rigid, porous bottom to support filter media and eliminate the need for graded gravel with its attendant troubles dates back 30 years. The early porous plates proved to be either too weak, when pea gravel was bonded together, or vulnerable to clogging, when finer aggregate was utilized. The porous plates used today in more than 300 installations were developed in 1934 by the Carborundum Co. The pores of these plates approximate the structure of torpedo sand.

Relatively large grains of electrically fused aluminum oxide are mixed with a ceramic bond, molded into plates, and fired in a kiln at approximately 2,400°F. Such a vitrified product is sufficiently strong for filter bottom use, besides being completely water- and acid-resistant.

The standard and most economical size of plates for use in a filter bottom is 12 × 12 in., less $\frac{1}{8}$ in. allowed for cement to seal joints and for variations in the spacing of holddown bolts. Special plates to fit circular filters or those with odd dimensions are easily manufactured. Large, rectangular plates and one-piece disks for small circular filters can also be made, at a somewhat higher cost per unit area.

Filters equipped with porous-plate bottoms function in the same way as those with other types of underdrains

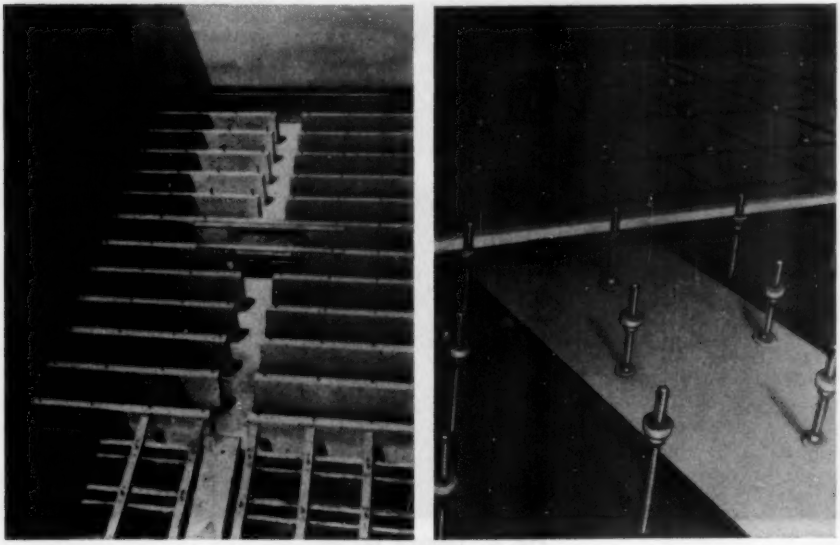

Fig. 2. Porous-Plate Bottom

The photographs illustrate two methods of supporting the porous plates: left, concrete piers; right, bolts anchored in floor.

but avoid such problems as mixing of the sand and gravel. The porous-plate bottom permits a reduced depth of filter media, which is hazardous where graded gravel is used. The chief virtue of the porous-plate bottom, however, is the elimination of graded gravel support for the filter medium. Because the filter structure is relatively shallow, existing construction can frequently be salvaged in filter rehabilitation. Operating heads can be reduced slightly—a small advantage, but important cumulatively. Furthermore, saving in wash water is often possible because of the exceptional uniformity of the filter wash.

Several methods have been devised to support the porous plates: [1] concrete piers in which corrosion-resistant holddown bolts or fabricated shapes are anchored, with the plates being held down by a washer and nut after setting with joint-sealing cement (Fig. 2, left); [2] completely false bottoms utilizing steel, reinforced concrete, or timber beams, or long bolts anchored in and extending from the structural floor (Fig. 2, right); and [3] a vitrified-clay tile support, eliminating the need for holddown bolts. An interesting development is an automatic-backwash design in which narrow portions of the filter length are trapped and washed progressively, while the rest of the filter remains in normal operation.

Wagner Bottom

The Wagner underdrain (Fig. 3) comprises a primary distributing system, consisting of a central manifold and laterals, and a secondary distributing system, consisting of Wagner precast blocks between the laterals. This filter bottom is in use at almost 500 installations, with a total capacity of almost 3,000 mgd.

The spacing of the laterals in the primary distributing system conforms to the block dimensions and the outside diameter of the laterals. For smaller installations, a pipe manifold may be used; for larger installations, a rectangular manifold is preferred, as it reduces the amount of fill required under the laterals. By slightly recessing the filter floor for the manifold, fill is eliminated entirely. The Wagner blocks are situated between the laterals. In smaller installations, a single row of blocks is employed between the laterals; in larger ones, a double row of blocks may be used in order to decrease the number of laterals.

The laterals have distributing orifices underneath, throughout their length. Nozzles are installed in the top of the manifold to distribute and collect water over the area it serves.

Wagner blocks are available in various sizes, the most popular being $10\frac{3}{8} \times 9\frac{5}{8} \times 4\frac{1}{2}$ in. This block requires 6 lb of cement and 12 lb of sand and weighs 22 lb finished. The required number of such blocks can be roughly estimated by multiplying the square feet of filter area by 1.2.

The Wagner block is essentially a grid, with open bottom and vertical slot openings and lugs on the sides. The individual blocks are easily made in a special machine at the construction site by local labor. It is estimated that two men should be able to construct 80–100 blocks in an 8-hr day.

Gravel of a size and quality suitable for bottom layers is difficult to obtain and very expensive. In the past, it has frequently been necessary to compromise between reduced cost and lower efficiency. Wagner blocks are now used instead of the very coarse bottom layers of gravel and perform far more efficiently in the initial stages of secondary distribution of wash water than

is possible with hand-placed pebbles of the size and quality available. Furthermore, a total of only 14 in. of graded gravel ($1\frac{1}{2}$–$1\frac{1}{8}$ in.) above the blocks is necessary. Accordingly, Wagner underdrains require 4–10 in. less gravel than the conventional type.

During the backwash operation the water enters the laterals from the manifold and is discharged downward through the orifices underneath. The jets of water are harmlessly dissipated on the concrete floor. The flow is then distributed laterally, enters the slots near the bottom of the blocks, and is discharged upward through the slits. The blocks provide a freeway over the entire filter floor, so that any minor pressure differences over the bottom are immediately balanced. The combined discharge areas of the slits in the blocks and the spaces between them are many times the total area of the orifices in the laterals. The blocks do not require the weight of gravel to hold them in place. As the lateral orifices are perfectly protected by the blocks, no opportunity is presented for partial or complete choking of the primary distributing orifices by coarse gravel.

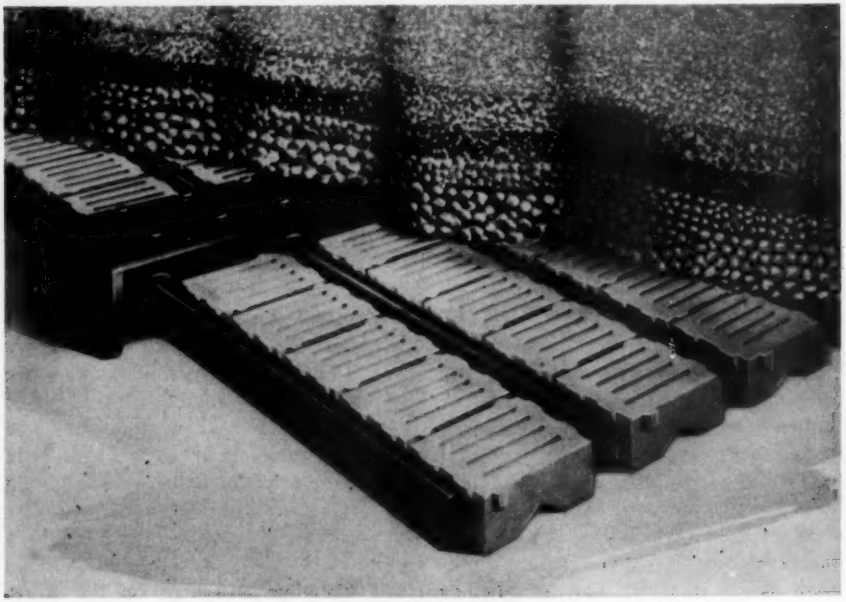

Fig. 3. Wagner Bottom

In large installations, a double row of blocks may be employed between laterals to decrease their number.

The primary distributing system is completely accessible for inspection with a minimum amount of effort, as the blocks may be easily removed from their operating position. A further advantage is a saving of wash water, owing to its uniform distribution. Simi-

larly, the design results in the efficient collection of filtered water.

Wheeler Bottom

The Wheeler filter bottom, developed by William Wheeler, was first installed at Belfast, Me., in 1913. There are now two basic types: the monolithic, constructed as a single concrete slab; and the precast, constructed of standard precast concrete blocks grouted in place. Both types include these four essentials: [1] a false bottom or floor supported at a height of 3–22 in. above the actual floor of the filter; [2] inverted pyramidal depressions, or hoppers, in the false bottom; [3] porcelain orifices at the apexes of the inverted pyramids; and [4] porcelain spheres placed in the inverted pyramids to support the gravel layer.

In operation, the water filters downward through the sand and gravel, between the porcelain spheres, through the porcelain orifice at the bottom of the inverted pyramid, and into the effluent collecting chamber. In backwashing, the flow is reversed. The loss of head in the Wheeler bottom itself, during the filtering operation, is ap-

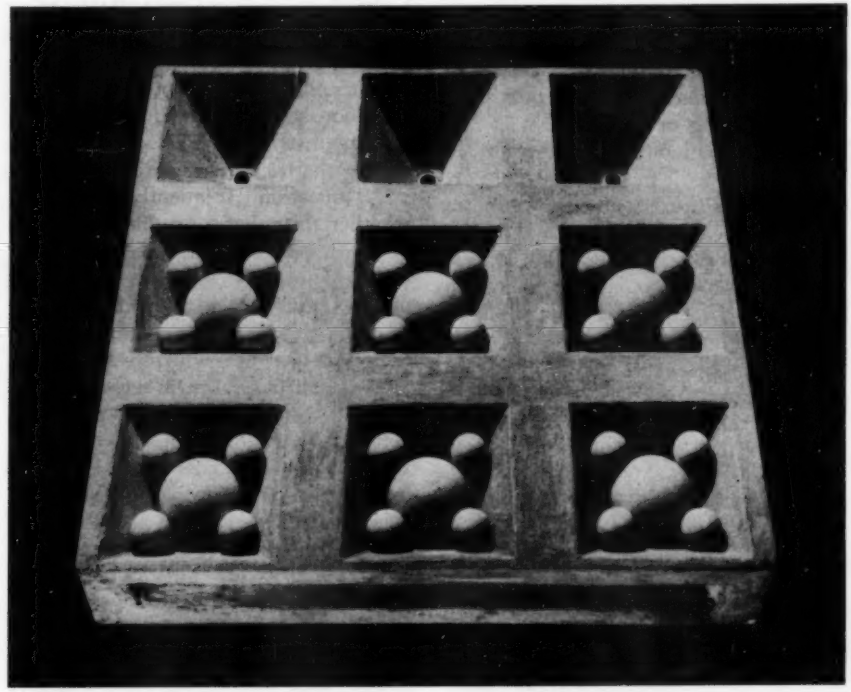

Fig. 4. Wheeler Bottom

The precast block is 2 ft square and 4 in. thick. Each pyramidal depression contains one 3-in. and four 1½-in. porcelain spheres.

proximately 1 in. During backwash the loss of head is 2.08 ft with the precast type and 5.11 ft with the monolithic type at a 36-in. rate of rise.

Monolithic Type

For the construction of a monolithic Wheeler bottom, portable, machined cast-iron pyramidal forms and appurtenances are furnished by the manufacturer. These can be removed from a filter after the concrete has hardened and can be reinstalled in the next filter without cutting or fitting.

The supporting piers of reinforced concrete are built first. Then the portable Wheeler forms and the reinforcing steel are set, and the concrete is poured to form the pyramidal depressions. After the concrete has been cured, the porcelain spheres are placed in the depressions. Fourteen spheres —five 3 in., eight 1¼ in., and one 1⅜ in. in diameter—are placed in each inverted pyramid. The gravel and sand layers are then built up.

Precast Type

The precast type of Wheeler bottom is made of high-strength concrete blocks reinforced with welded steel bars and cast in machined metal forms, especially designed to provide a hard, dense concrete in the inverted pyramids. The blocks are made at a central plant and shipped to the job site by truck or rail. Though the blocks are quite heavy—42 lb per square foot, including porcelain—the transportation cost usually amounts to only about 10 per cent of the installed cost.

The precast block (Fig. 4) is nominally 2 ft square and 4 in. thick. Each block contains nine inverted pyramidal depressions spaced 8 in. apart, center to center, each depression being equipped with one 3-in. and four 1½-in. porcelain spheres. The piers on the filter floor, which support the precast blocks, may vary in height from a minimum of 3 in. to a maximum of 20 in., depending upon the local structural and hydraulic requirements. Reinforcing steel, which projects from the piers into the grout space between the blocks, anchors the Wheeler bottom to the filter floor structure, furnishing protection against any possible uplift forces during the backwash operation.

A question frequently asked is whether the spheres are likely to move or be displaced during normal operation. To throw some light on this matter, a test block was set up in the laboratory, with a pressure chamber underneath, from which water could flow up through the porcelain orifice and through the spaces between the spheres as it does during washing. Backwash head under the block was built up to more than 70 in., causing a backflow equivalent to a rise of nearly 60 in. per minute or 37 gpm per square foot. Even at this high figure, which is nearly triple the normal wash rate, the spheres remained fixed in position and the flow was evenly distributed.

The long and continued popularity of the Wheeler filter bottom is evidence of its sound basic design. The cost is low. The loss of head is slight, and the wash water distribution is uniform. Recent inspection of Wheeler bottoms that have been in service for a number of years showed the porcelain spheres and concrete to be in excellent condition.

Methods of Lifting Elevated Tanks

By Bernard Whitteron

A contribution to the Journal by Bernard Whitteron, Civ. Engr., Howard Humphreys & Sons, London, England.

A RECENT article by H. J. Draves (*1*) on lifting an elevated tank recalls a similar problem faced by the author when he was an engineer for the Bagdad, Iraq, Water Board. Owing to limited local resources, the author's method was not so elegant as Draves' device of raising column extensions built around the existing stanchions. Nevertheless, the present author's experience serves to stress the point that, with care and planning, an elevated tank can be lifted safely and very economically.

Fig. 1. Tank Being Lifted

Temporary cribbing supported the tank until additional panels could be inserted.

The problem involved raising a 250,000-gal tank (Fig. 1) at least 15 ft.

Fig. 2. Completed Tank

The two lower panels, each 7½ ft high, are newly installed.

Including the steel tower, the tank weighed 86 tons and was built on a concrete framing 21½ ft high. The tower

comprised an outer ring of sixteen 22-ft columns. A series of holes, 9 in. apart, center to center (the limit of the jacks' travel was 9 in.), was drilled in three of the columns. The jack heads lifted against joists bolted to the inner face of the columns at the topmost holes. Temporary cribbing was built under the intermediate columns. When the jacks were fully extended, the cribs were wedged in tightly, and the tank was allowed to rest on them. The jacks were then lowered, the joists were dropped one notch, and the process was repeated. After the tank had been lifted 9 ft, a 7½-ft panel was introduced, and the lifting operation was continued until a second such panel could be put in place. Figure 2 shows the tank with the two new panels inserted.

To raise the tank 9 ft took 4 days. From time to time winds reaching 40–50 mph occurred during the work. The tank was anchored by long wire rope ties to prevent it from overturning. The column feet tended to assume a position as much as 3 in. out of true, probably because of inaccuracies in the new bracing, but this condition was corrected and the job went very smoothly.

Sling Method

On an earlier occasion it had been found necessary to raise a number of 28 × 28 × 12-ft sectional-plate square tanks (Fig. 3). These were lifted on rope slings passing over outriggers temporarily bolted to the top of the tower. The height of the tower was then increased by constructing additions at the top. Because it was thought desirable to renew the jointing on one of the tanks, it was dismantled and later reerected by conventional methods. Comparison proved—although proof was not really needed—that lifting in slings was quicker and far more economical than dismantling and reerecting.

Developments often make it necessary to increase the height of elevated tanks. It is most interesting to see how quite difficult problems of this type can be solved by the exercise of ingenuity instead of scrapping the old and starting anew.

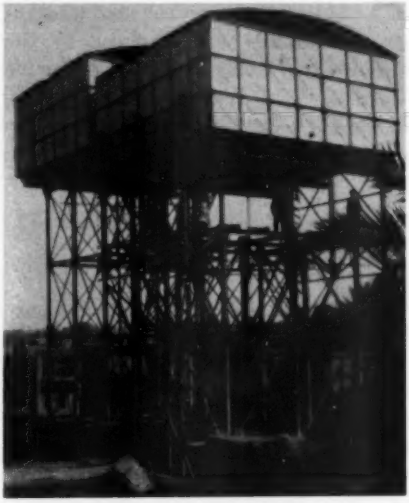

Fig. 3. Sling Lifting

These tanks are being lifted by means of wire rope slings passing over temporary outriggers bolted to the top of the tower.

Reference

1. DRAVES, H. J. Raising an Elevated Storage Tank. *Jour. AWWA*, **45**:1245 (Nov. 1953).

Equipment and Layout of Meter Maintenance Shop

By David J. Ford

A contribution to the Journal by David J. Ford, Asst. Sales Mgr., Ford Meter Box Co., Wabash, Ind.

MANY water works men are faced with the task of laying out a new meter-testing shop or improving the arrangement of an old one. The numerous advantages to be gained from the use of proper equipment, well located in the space available, justify careful study and planning. The following suggestions on what to use and where to place it may be of some help.

Meter shops range in size from those for repairing and testing a few dozen meters a year to some which work on more than 10,000 annually. In addition to the number of meters, other conditions that can affect the size, equipment, and layout of the shop include:

1. Number of makes and types of meters used, which governs the size of the repair part stock and the storage space for it.

2. Local water quality, which determines the extent of corrosion, liming, incrustation, and wear.

3. Location and type of meter settings, which control the condition of the meter register and the outside of the casing. The repair of frozen meters is sometimes a tremendous job in certain meter shops. In other localities, meter casings become caked with mud, and, when the dial glass is broken, the entire register may be mud clogged.

4. Local practice or state requirements specifying how often meters shall be tested.

5. Customer ownership of meters, which calls for special care in identifying and segregating meters so that they can be returned after testing.

6. Existence of special cleaning practices in refurbishing meter casings during the process of repair and testing. Whether done by wire brushing, acid dipping, sand blasting or painting, special equipment is required.

In planning the equipment and layout of any meter shop, some or all of the above factors must be borne in mind. Possibly more important than any of them is the trend toward increased numbers of meters and toward more frequent repair as they become older. All planning should be done with an eye to the future.

Selection of Equipment

The basic equipment, exclusive of a desk or file for meter records, is listed below. The most essential items are given first, followed by those which would be justified only in large shops:

1. An accurately calibrated tank, or a plain tank on an accurate scale, to check the meter being tested against the actual volume causing a given registra-

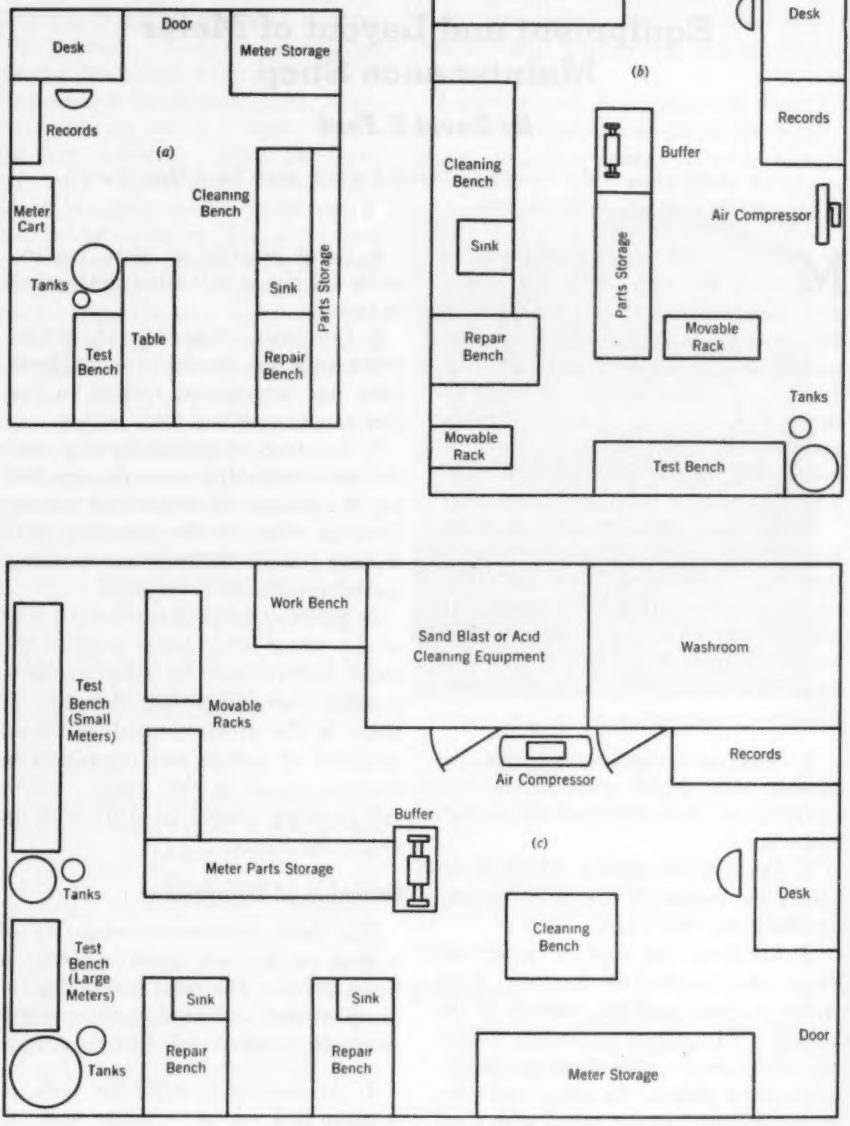

Fig. 1. Suggested Shop Layouts

Key: (a) 12 × 15 ft; (b) 15 × 20 ft; (c) 30 × 20 ft.

tion. Drainage piping for the tank (or tanks) should be of sufficient size to empty it quickly.

2. A substantial workbench with vise, hammer, wooden or leather mallet, screwdrivers, wrenches, pliers, files, scrapers, wire brushes, and other tools.

3. A sink with running water, preferably both hot and cold, for washing meters and parts.

4. A test bench for domestic-size meters (through 1 in.). Although meters can be connected up with ordinary fittings, there is a saving in time and effort if a test bench is used for smaller meters, which probably constitute up to 99 per cent of the total tested. The number of test units on the bench would be governed by the volume of work. Series testing is generally economical. For more efficient testing, benches may provide for hydraulic clamping of meters and automatic shutoff of flow at the proper tank level.

5. A rate-of-flow indicator.

6. An electric grinder, with wire brush and buffer, which has a wide variety of uses.

7. Storage bins or drawers for meter parts.

8. An adapter for testing 1¼-, 1½-, and 2-in. meters. This accessory, which can be attached to the test bench, provides ease of testing of larger meters at a minimum investment.

9. A small air compressor. Only experience will indicate the many ways in which compressed air is convenient for cleaning, drying, painting, and similar operations.

10. A bench drill press or an electric hand drill, a widely useful device. Electrical outlets should be conveniently located.

11. Chemical cleaning equipment. Experts disagree greatly on the advisability of using acids or other chemicals on meter parts. The cleaned pieces, especially when treated with acid, have a fine appearance but may be slightly reduced in size, so that meter performance is affected. When chemical cleaners are used, precautions must be taken to prevent health hazards. Proper rinsing facilities and exhaust fans should be provided.

12. A test bench for 1¼-, 1½-, and 2-in. meters. When enough large meters are to be tested, a special bench for one or more of them is a good investment. Calibrated tanks large enough to hold water for tests run at high rates of flow are also desirable for quantity testing of large meters.

13. An electric or air-driven impact wrench. This provides for the speedy removal of large meter casing bolts.

Lack of equipment need not result in poor testing of small meters. With an accurate tank, a watch, and a few valves and fittings, it is possible to do a thorough testing job. Some or all of the additional items listed above will, however, increase efficiency and are usually a good investment.

Shop Layout

After the amount and type of equipment to be included in the meter shop have been decided upon, attention should be given to proper placement in the allotted space. There are a number of requirements to be satisfied and a good many valuable principles to be applied. The arrangement adopted should provide the best flow of meters through the shop. The distance between adjacent stations should be short, and easy methods of moving the meters should be available.

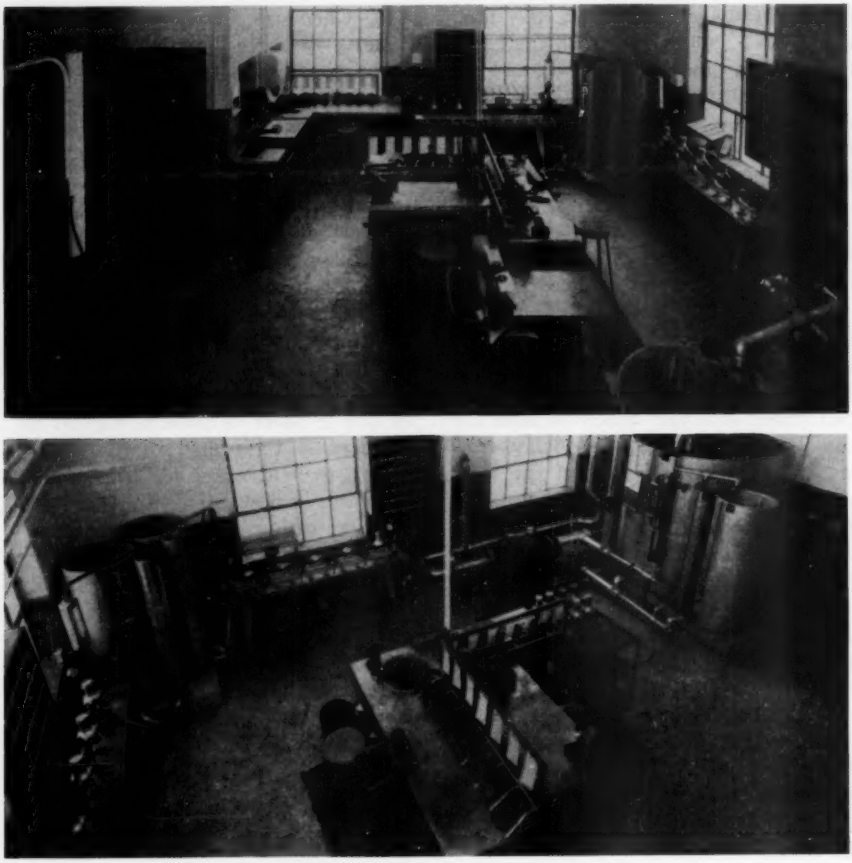

Fig. 2. Two Views of Wichita, Kan., Meter Shop

In the top photograph, the storage racks are visible in the left foreground, with the grinder and buffer a little to the right; at rear left is the acid cleaning room, flanked by a sink and workbench; test benches and tanks for small meters are at rear right; in the right foreground, part of the large-meter testing equipment can be seen; at center are other workbenches, with a portable rack for small meters in front of them. The lower photograph, taken from atop the acid room, gives a good view of the small-meter test benches and the center workbenches. Behind the large-meter tanks at right rear, the drill press is partly visible. The shop area is approximately 625 sq ft.

Basically, a meter in the shop follows this general routing: the incoming meter is tested and stored; next, it is washed and disassembled; the parts are cleaned, nonserviceable parts are replaced, and the meter is reassembled; then it is taken to the test bench and given the required tests; if its accuracy is within the limits prescribed, it is sent to outgoing storage; if further re-

pair is necessary, the meter is returned to the repair bench, and part of the cycle is repeated.

The nature of this cycle suggests the necessity for good material-handling practice to simplify as much as possible the physical work involved. This objective can be approached by:

1. Locating the meter shop on the ground floor. This eliminates elevators and speeds up supply.

2. Arranging for a loading dock near the door of the meter shop. This also will shorten the distance supplies must travel.

3. Maintaining good lighting, either natural or artificial, throughout the shop. Work tables should be arranged so that the light from the windows does not shine into the repairman's eyes. Good operation in a meter shop depends upon the ability of the workmen to see what they are repairing, inspecting, or testing—jobs in which clear vision is all important.

4. Providing for both hot and cold running water. Washing meter parts with hot water and soap is the most harmless method in use and is sufficient for many parts. Hot water is essential, especially in cold weather.

5. Locating a motor-driven buffer near the repair bench. It is important to have this machine within a very few steps of the repairman, to avoid continual walking. The buffer should be equipped with a dust collector or exhaust.

6. Washing the exterior of dirty meters when they begin the processing cycle. This practice will improve working conditions by producing a much cleaner meter shop.

7. Making compressed-air hoses available to both the repairman and the meter tester.

8. Providing storage space for both incoming and outgoing meters near the door. There they can be easily counted and readily moved in or out.

9. Placing the meter record file near the door and the meter storage area.

10. Keeping commonly used parts on the repair bench and storing other parts nearby for easy access.

11. Avoiding extensive paper work in the parts checkout procedure. Time will be saved and the repairmen will be appreciative.

12. Equipping the shop with carts or rolling racks to be used for moving meters from one station to another and for storing meters. Each rack or cart should hold a specified number of meters so that quick inventory can be taken. It should be easy to reach every meter and read its tag. In a small shop, ten meters per cart would be enough; in a large shop, 100 meters arranged on a rack would be more efficient. It may be desirable to provide facilities for hooking meters on the rack in a vertical position. With that system, each meter is on the outside of the rack and can be removed or examined without disturbing any other. Dock facilities can be arranged so that an entire rack filled with meters can be rolled alongside a truck for loading, thus eliminating one handling operation. The benefits from mobility of meters should not be underestimated; any practice that will speed up the processing cycle is worth serious consideration.

It is usually impossible to adhere closely enough to theory to attain the ideal layout, chiefly because existing facilities impose limits upon the designer. It is cheaper to work such facilities into the layout than to alter them to fit the ideal. It may, however, be worth while to compare the cost of

changing the existing facilities with the value of the increased efficiency made possible. The features affecting meter shop design include: shape and size of room; existing piping; location and size of windows, doors, and columns; size of available equipment, such as filing cabinets and workbenches; and availability of space for meter and parts storage outside the room. The latter condition can be an advantage if there is not enough space inside the room for storage. Otherwise, to have the storage in another room means wasted steps every time a part or meter is moved.

The three suggested layouts illustrated (Fig. 1) serve to demonstrate the principles mentioned previously. The prevailing conditions determine the layout. In the small-shop layout (Fig. 1a) the meters move clockwise about the room with only short distances between adjacent stations. The layout in Fig. 1b provides more storage space, a buffer, more bench space, and a larger test bench. For larger cities, the arrangement in Fig. 1c provides for two separate repair benches, two test benches—one for smaller meters and one for meters larger than 1 in. —a cleaning room, and a washroom. Movable racks are shown in all three layouts. Figure 2 illustrates an actual layout.

Meter shop layouts embodying the principles of efficient material handling, using proper equipment, and having real regard for the workman's needs can definitely save time as well as labor.

Acknowledgment

The author wishes to acknowledge gratefully the many helpful ideas gained through consulting and corresponding with E. J. Good, Indiana Gas & Water Co., Lafayette, Ind., and with H. W. Niemeyer and A. McCauley, Indianapolis Water Co., Indianapolis, Ind.

Maintenance and Repair of Nutating-Disk Meters in Small Plants

By Russ Olsen and Henry De Pagter

A paper presented on Sep. 3, 1953, at the West Virginia Section Meeting, Morgantown, W.Va., by Russ Olsen, Sales Engr., and Henry De Pagter, both of Badger Meter Mfg. Co., Milwaukee, Wis.

THIS paper will discuss the maintenance and repair of nutating-disk meters, particularly in the small plant. It might be mentioned at the outset that, if facilities permit, every new meter should be tested before being placed in service, so that a complete history will be available when the meter is eventually brought in for inspection or repair.

Cleaning

Every meter coming into the shop for repairs should be dismantled and all parts thoroughly cleaned. If there is no time to clean a meter immediately, one end of the spud should be capped and water run into the meter by holding it under a faucet. When the meter is full of water, cap the top or open end of the other spud and let the meter stand in an inverted or upright position until it can be dismantled. This method keeps the deposits from the water soft and makes it easier to dismantle and clean the meter.

A cast-lead block, approximately 1 ft square and 2 in. thick, is a very handy tool for the meter repairman. When disassembling a meter that has been in service for many years, it is sometimes difficult to remove the interior parts from the casing. In that event, pick up the meter, after removing the bottom, and give it a few sharp blows on the lead block to break the seal between the chamber and the casing. The block will take the impact and will not nick or damage the casing.

Numerous methods and chemicals are utilized for cleaning water meters. Hot alkaline solutions are used to wash off oil and grease films, while cold acid solutions remove lime deposits, rust, and corrosion. Rubber in meters is not normally affected by either acid or alkaline solutions, but the temperature at which alkaline solutions are usually employed (approximately 160°F) would ruin hard-rubber parts. Regardless of which type of solution is used, meter parts should be rinsed in clean, cold water before reassembly, to avoid corrosion from acids remaining in the crevices. Overdipping in strong acids should likewise be avoided.

Chamber and Disk

In making an inspection of the inner parts of the meter, start at the heart or motor, which is the chamber and disk (Fig. 1). First, inspect the chamber for pit holes. If the ball sockets of the chamber are very badly pitted, a new chamber is recommended. When the ball sockets are in good condition, even if the cone or surface of the chamber is pitted, it may not be

necessary to throw the chamber away. A little experience will soon enable the repairman to exercise proper judgment.

If the meter disk has a thrust roller, check the slot for excessive wear and corrosion. Examine the thrust roller insert (or bearing plate, as it is sometimes called), provided the chamber has one. If not, it is possible to send the chamber to the manufacturer to have it slotted for the thrust roller insert, provided the rest of the chamber is in good condition and the wear of the slot is not more than $\frac{1}{16}$ in. Should it be necessary to replace a partition plate, be sure that the clearance between the disk ball and the plate is not too great, as this condition would permit water to pass from the inlet to the outlet of the chamber without registering on the meter. Be sure the partition plate is tightly secured, because a loose plate will rub on the disk ball, causing friction and meter failure.

Next, check the disk with a straightedge to see if it has been warped by hot water. Look for cracks in the disk, as they may cause it to break in service. Examine the disk balls for swelling due to hot water. Check the thrust roller hole for wear, because an oblong or badly worn hole will provide a very loose bearing for the roller, causing a binding that will result in low-flow registration losses. It will also lead to excessive wear in the thrust roller and chamber slot. Inspect the thrust roller for wear and be sure that it turns freely in the disk. A roller that cannot revolve properly will develop a flat spot on its head, causing a great deal of friction and unnecessary wear in the thrust roller slot of the chamber. Finally, examine the disk spindle for wear.

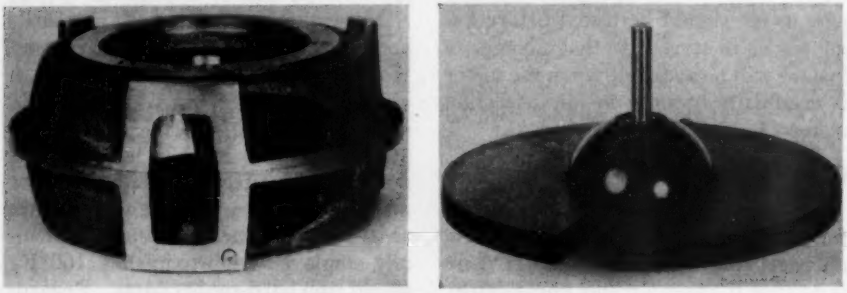

Fig. 1. Chamber and Disk

The disk (at right) has a thrust roller, which a number of other makes of meter do not employ.

After badly defective or worn parts have been replaced, the disk is inserted in the bottom of the chamber, and the chamber top is placed in position and closed. To determine whether the disk has proper clearance, a new disk and chamber can be used for comparison. Without correct clearance, the meter will not give a good test result.

If there is too much clearance, the chamber is taken apart and, with the disk still assembled, a number of pieces of brass shim stock, ranging in thickness from 0.002 to 0.007 in., are placed

under the disk ball, one by one, the chamber being closed in the usual manner after each trial. When a piece of the right thickness to give the proper clearance has been found, the disk is taken apart for insertion of the shims between the half-balls and the disk plate. (Before disassembling, however, mark the exact position of the balls in relation to the plate with a pencil, so that they can be replaced in the same way. Unless this precaution is taken, there may be a faulty fit, because of uneven wear on the balls and chamber sockets due to lateral thrust.)

When inserting the shim, consideration should be given to the likelihood of differences in wear. Thus, if the required shim thickness is found to be 0.005 in., an 0.003-in. shim should be placed between the bottom half-ball and the disk, with an 0.002-in. shim between the top half-ball and the disk.

It may be well to describe briefly the proper way of performing the shimming operation. Cut the shim in the shape of a cross, and lay the center of the cross over the center of the ball socket in the chamber. The weight of the ball, when placed on the cross, will force the shim stock to the bottom of the socket, causing the arms of the cross to turn up around the ball. This method avoids wrinkling or creasing of the shim, which would result in false readings. In view of the repair time required for shimming, it may often prove more economical to use new, oversize balls—or even new disks, complete with oversize balls—rather than shims. When a new disk is employed, for this reason or because the old disk has been damaged beyond repair (by hot water, for example), disks with ball sets of various sizes should be tried to obtain one with proper clearance.

On reassembling the disk and chamber, blow gently through the outlet port to test the freedom of movement of the disk. If it sticks, take hold of the top of the disk spindle and turn it counterclockwise for approximately 10–20 revolutions. Then remove the disk from the chamber and examine it to see where it has been binding, as indicated by highlights or shiny marks on the disk or ball. A nick in the finished surface of the chamber will cause the disk to hang up at that point. Use a three-cornered scraper or any sharp instrument to eliminate all obstructions. Assemble the disk and chamber, and check again.

Gears

The gear train should run freely and mesh smoothly. Check all spindles for wear, and bushings for worn and oversize holes. Replace if worn. Check all gear teeth to see if they are worn. If the gears revolve around the spindle, also check the hole in the gear for wear. Check the control roller to see if it is worn or badly swollen. It is very important to have a control roller of proper size, as the closer the fit to the disk spindle (without binding as it revolves), the better the accuracy on fine flow tests. Also, the control roller must run freely on its pivot or bearing, or else it will show a considerable amount of wear in a very short time. Flat spots on the roller are an indication that it is sticking.

Next remove the meter change gear and examine its teeth. Take off the stuffing box nut, and discard the old packing. Check for wear on the upper driving pawl and spindle. If excessive wear or corrosion is found, consult the manufacturer. Should this condition be due to the composition of the

water, the manufacturer or his metallurgist can suggest steps to be taken to overcome the difficulty.

Reassembly

In reassembling the meter, insert the upper driving pawl spindle in the inverted main casing. Then screw the gear train in position, either in the casing or on top of the chamber, depending on the make of meter. Drop the chamber into the casing, making sure that the bottom lugs of the chamber are flush with the gasket seat of the casing. Apply thumb pressure on the bottom of the chamber to place it in proper position. If the chamber does not fit snugly against the outlet port of the casing, some of the water will bypass the meter, and registration will be very inaccurate.

Blow gently into the outlet port of the meter to check the freedom of movement of the disk and gear train. Insert a new bottom gasket in place and bolt the bottom in position, tightening alternate bolts a little at a time. Then set the meter in an upright position and repack it with new stuffing box washers. If possible, do this in a test machine. Before turning on the water and subjecting the meter to pressure, screw down the packing nut lightly. Turn on the water and adjust the nut until it stops leaking. (Making the stuffing box nut too tight will squeeze the spindle, causing a tremendous amount of friction and retarding registration of small flows.) Keeping the pressure on the meter, let the change gear drop down on top of the stuffing box nut, lift up the gear slightly, and tighten the set screw. The upper driving spindle will thus be forced up by the pressure in the meter, representing the actual condition in the field. When the register is properly placed on the meter so that both gears mesh, they will at all times remain in their correct positions. If the meter gear were placed on the spindle in the down position and the register and gear set to mesh, water pressure might cause the spindle and meter gear to rise and become disengaged from the register gear, resulting in a dead meter.

If the register is undamaged but does not run freely, soaking it in penetrating oil and then in light lubricating oil may prove effective. If the register then runs freely, without too much play in the gears or wear in the bushing, it will not have to be disassembled and repaired. Register gears turn slowly, so that there should not be excessive wear on gears, spindles, and bushings.

Summary

Some of the important points with regard to nutating-disk meter maintenance and repair are summarized below:

1. Clean all meter parts thoroughly.
2. Make sure the gear train runs freely.
3. Check the action of the disk in the chamber before and after assembly in the main casing.
4. Remember that friction is just as detrimental to a meter as leakage.
5. Store meters away from steam pipes, hot-water lines, furnaces, and other sources of heat.
6. Use a new meter as a standard of comparison for tolerances and clearances.
7. Do not hesitate to call on the manufacturer and his staff for help.

Organization and Activities of the East Bay Municipal Utility District

By John W. McFarland

A paper presented on Oct. 28, 1953, at the California Section Meeting, San Francisco, Calif., by John W. McFarland, Gen. Mgr., East Bay Munic. Utility Dist., Oakland, Calif.

THE East Bay Municipal Utility Dist. has many features that will be of interest to those unacquainted with this type of organization. The community served, which includes the residents of thirteen cities on the east shore of San Francisco Bay, is proud of its water utility and has often gone on record to that effect, although almost everyone refers affectionately to the water service as "East Bay MUD."

The first water distribution system in the East Bay area was established by the College of California in 1867. From then on, water distribution was handled by a series of privately owned companies that gradually merged their operations until, in 1923, the district was formed to take over water service for the region. Under the terms of the Municipal Utility District Act enacted by the California legislature, the East Bay Dist. is governed by a board of five directors, elected at large, although required to live within specific geographical wards. The only compensation they receive is $10 per meeting, for not more than two meetings a month. The district, a public corporation, is vested with all of the authority and responsibility normally involved in a proprietary interest of this type.

Originally, about $65,000,000 was spent to establish a source of water supply on the Mokelumne River, to build an aqueduct from it, and to purchase the privately owned distribution system. The first water from the Mokelumne River reached Oakland on Jun. 23, 1929, and has been flowing in increasing quantities ever since. In the 208-sq mile area served, there are now more than 1,000,000 consumers, receiving their water through 234,000 meters and 2,250 miles of pipe. A summary of general statistical data on the facilities of the district, including a flow diagram, is given in the Appendix.

Financial Structure

The East Bay water utility is truly "big business." Its assets currently total $127,000,000, and it has a net worth of $76,000,000. The present bonded debt, which is being steadily retired, amounts to $45,000,000. Out of an annual budget of approximately $15,000,000, more than $7,000,000 is invested in capital improvements, extensions, and replacements.

The financial structure of the district is designed to pay operating expenses, retire debt, and provide for some portion of the capital improvements necessary to meet the growing demands of the area. The fact that the water rates of the district have steadily decreased over the years is indicative of the re-

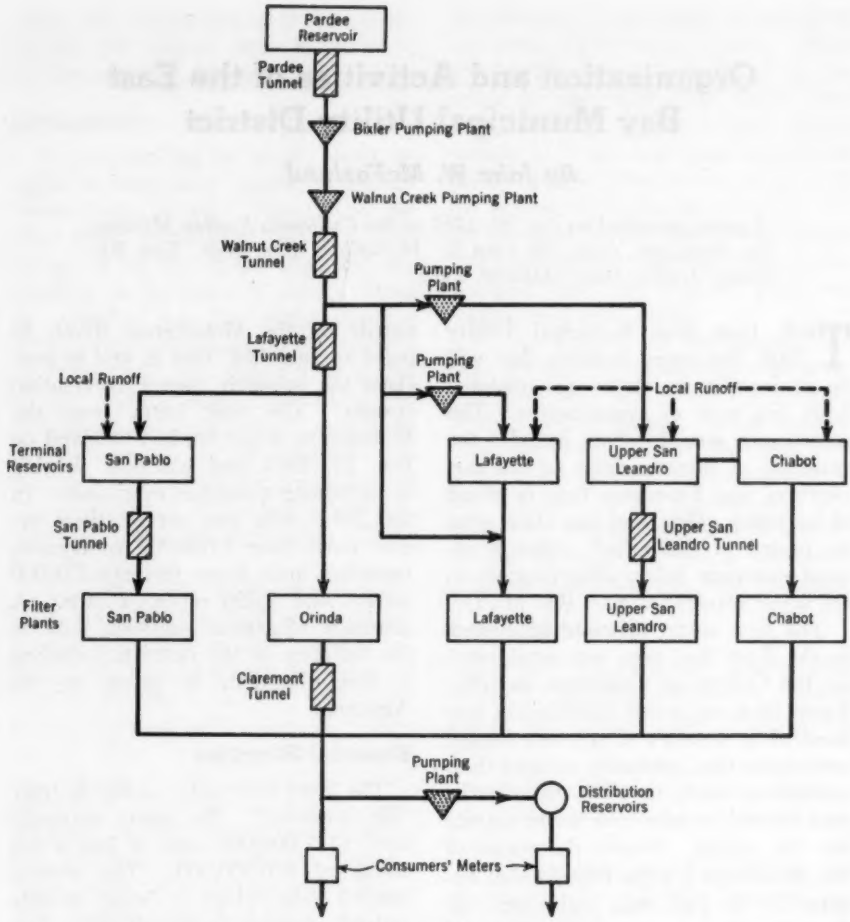

Fig. 1. East Bay District Flow Diagram

The district serves more than 1,000,000 consumers in a 208-sq mile area.

sults achieved. In 1953 a 10 per cent reduction was put into effect. The current water rates are the lowest in the San Francisco Bay area.

Water Supply

The district's Mokelumne River supply comes from a mountain watershed 100 miles from the bay area. At present the district has rights to 225 mgd. Water consumption now averages 115 mgd, with a maximum day of 170 mil gal. All of the drinking water passes through rapid sand filters, the district being the only large water utility on the Pacific Coast of which this is true. The district is fortunate to have in storage, on the Mokelumne River and in local impounding reser-

voirs, a 2-year supply of water to meet any emergency or contingency.

Personnel and Public Relations

Important assets in any organization are the people that make it run. The ability and understanding of the elected directors has made it possible for the district to operate smoothly and effectively. The employee group numbers 1,200. Constant attention is given to improving working conditions and providing benefits to meet the standards in the area. The organizational structure is flexible and is adjusted whenever necessitated by changing circumstances. A continuous program of training and development assures that the best possible employee is assigned to every job.

Without public acceptance, the best technical utility operation falls down. Consequently, the district gives a great deal of thought to its public relations program. Obviously, such a program cannot be assigned to a single individual or department. Great emphasis must be placed on the fact that each employee is, in his own way, a public relations representative of the organization, particularly in branch offices. The manager of the business office in each city is expected to represent the district in his community and to submit reports on its attitude toward the utility.

The district participates actively in all community programs, working closely with the various chambers of commerce, industrial organizations, and other important civic groups, in order to acquaint them with utility problems and assist them in planning future growth.

Another important sphere of cooperation involves the various city councils and boards of supervisors, who have problems of their own. No effort is spared in working with these representatives of the public.

Future Plans

Certainly, it is not enough to rest on current achievement. The future is the greatest challenge to the water works industry in California. The district is not unmindful of this fact, and one division in the engineering department is devoted to a study of long-range water needs. Estimates indicate that 350 mgd will ultimately be required to serve 2,600,000 consumers when the service area has expanded to 400 sq miles as envisioned.

Briefly, the plans to acquire additional water include a third aqueduct and three new dams and reservoirs, with a total capacity of 353,000 acre-ft, on the Mokelumne River. That stream has been selected because of the investment the district already has there, including a 100-ft right of way from the mountains to the bay. Furthermore, the public of the East Bay region demands a high-quality water such as is found in the Mokelumne River.

The realization of these projects will entail a great deal of work, not only by the engineers, but also by the district's legal and public relations staffs, consulting with other claimants to water from the Mokelumne River and informing the East Bay residents in order to obtain public support when it becomes necessary to vote the funds needed to acquire the additional supply. Thus, the utility is looking ahead so that future generations will enjoy the same advantages of an adequate water supply as were wisely provided for the present generation by the original directors of the district.

Sewage Disposal

The story of the East Bay Municipal Utility Dist. would not be complete

without a brief word about a subsidiary operation under its managament—sewage disposal. A special district has been formed under the Municipal Utility District Act. This district, including the cities of Alameda, Albany, Berkeley, Emeryville, Oakland, and Piedmont, was set up to handle the problem of sewage disposal by interception of the city-owned sewer systems, primary treatment, and discharge of the liquid effluent and digested sludge into the deep waters of San Francisco Bay. This organization is a part of the program to clean up all of the waters of San Francisco Bay under California state law. The plant to accomplish this objective cost approximately $25,000,000 and has a capacity of 100 mgd. Results to date have been eminently satisfactory, and the East Bay cities can now enjoy bay water free from pollution and unpleasant odors.

APPENDIX

Data on East Bay Municipal Utility District

Some general statistical information on the facilities and installations of the East Bay Municipal Utility Dist. is presented below. A flow diagram is shown in Fig. 1.

Primary watershed. Location: Alpine, Amador, and Calaveras counties. Area: 575 sq miles. Amount of runoff (in terms of Pardee Reservoir capacity): 47-year average, 3.5 ×; 5-year average, 4.1 ×; maximum year (25-year period), 6.4 × (in 1952); minimum year (25-year period), 0.9 × (in 1930).

Pardee Reservoir. Location: 38 miles northeast of Stockton, on Mokelumne River. Area: 2,200 acres. Capacity: 68.4 bil gal (209,950 acre-ft), equal to 620 days' supply at present (1953) average rate of 110 mgd.

Pardee Dam. Height above river bed: 358 ft. Width across top, 1,337 ft. Thickness: at base, 241 ft; at crest, 16 ft. Elevation: 575 ft (USGS datum). Power plant: 15,000 kwhr.

Mokelumne aqueducts. Total length: 94 miles, including 9 miles of tunnels, 4 miles of concrete pipe (9 ft), and 81 miles of steel pipe (54–68 in.). Total capacity: gravity, 92 mgd; pumped, 214 mgd.

Terminal reservoirs. Capacity (in billion gallons): Chabot, 4.1; Upper San Leandro, 13.5; Lafayette, 1.7; San Pablo, 14.0; total, 33.3.

Filter plants. Capacity (in million gallons per day): Chabot, 7; Upper San Leandro, 27; Orinda, 105; San Pablo, 54; Lafayette, 21; total, 214.

Distribution pumping plants. Total capacity (68 plants): 245 mgd.

Distribution storage. Total capacity (99 tanks and reservoirs): 403 mil gal.

Growth. The district's growth in consumers and facilities from 1940 to 1952 is summarized below:

Item	1940	1952	Increase *per cent*
Gross water consumption—*mgd*	45	112	149
No. of customers	148,329	227,803	53
No. of consumers	520,000	950,000	83
Distribution pipe —*miles*	1,681	2,207	31
Filter plant capacity—*mgd*	115	214	86
Distribution storage capacity—*mil gal*	323	403	24
Distribution pumping plant capacity—*mgd*	89	245	175

Preparation and Use of Activated Silica

By A. E. Griffin

A paper presented on Sep. 3, 1953, at the West Virginia Section Meeting, Morgantown, W.Va., by A. E. Griffin, Director, Technical Service Div., Wallace & Tiernan, Inc., Belleville, N.J.

ACTIVATED silica is unique in that it belongs to a small group of water works chemicals that must be produced at the point of use. Preparation at remote points is precluded because of transportation costs and spoilage. To a certain extent, this fact is advantageous, because it makes a low-cost chemical available to all sections of the country. On the other hand, it places some added responsibility on the shoulders of water works operators, although they have taken it in their stride and, after a few trials and errors, have become real experts at compounding this new product.

Once the knack of proper activation is learned, the rest is routine, because it entails little more than the addition of the prepared chemical, in proper amounts, at the proper point, in proper ratio to the coagulant used, and at the proper pH. Unless these details are given some attention, however, the use of activated silica can, in some instances, be detrimental to the formation of a floc, a characteristic that should always be determined in advance. The use of jar tests prior to plant scale application will eliminate many hours of anxiety and will actually save time.

Activation Process

To prepare activated silica properly, one should be well informed about the characteristics and idiosyncrasies of the product. Activated silica is a very useful chemical, but it has the ability to play tricks unless one is forewarned, because the active ingredients are small particles of silica (called micelles), which cannot be seen and which must be brought to just the right size and age.

Activation takes place in two steps. In the first, an unstable compound is formed, while, in the second, this compound is stabilized. Sodium silicate (Na_2SiO_3)—sometimes known as water glass—which, in itself, is completely ineffective as an aid to coagulation, is changed in composition in such a way that silica micelles are released from bondage to the alkali. Upon release, these micelles become negatively charged, migrate toward the positively charged floc, and merge with it. This has the effect of producing a strong, heavy floc that settles rapidly. If the silica micelles are too small, the negative charge will be weak, and the results can be unsatisfactory. If the micelles become too large, a gummy mass, known as silica gel, will be formed, likewise producing disappointing results. The importance of control in the preparation of this highly sensitive product is obvious.

Sodium silicate, the main raw material utilized, is a chemical of varying composition, with specific formulas for

particular usages. The formulation most frequently employed in water treatment contains 3.329 lb of SiO_2 (28.7 per cent) and 1.08 lb of alkali (8.9 per cent), expressed as Na_2O, per gallon. The difference between the weight of these combined ingredients and the weight of 1 gal of sodium silicate (11.6 lb) represents the quantity of water present.

To produce activated silica, the alkali in sodium silicate is wholly or partly neutralized. If the acid radical, known as the reactant, is added directly to full-strength sodium silicate, the whole mass will solidify instantaneously, forming solid silica gel, which is useless in water treatment. The problem is to release the micelle and then limit or control its growth before solidification takes place. The interval between the addition of the reactant and the formation of a solid gel is called the gel time.

The sodium silicate is diluted until the SiO_2 concentration is between 1.0 and 2.5 per cent. When an acid or acid radical is added in amounts sufficient to neutralize all or part of the alkali present, micelles are formed which grow at controllable rates, depending upon the extent of dilution and the degree of neutralization. If the SiO_2 content of the diluted silicate is greater than 3 per cent, the micelles group themselves into an unusable gel in a few seconds. On the other hand, if the SiO_2 content is less than 1 per cent, the micelles grow so slowly that the resulting mixture is ineffective as a coagulant aid.

Activated silica may be prepared either in batches or continuously. In batch preparation, the sodium silicate–acid mixture is vigorously agitated during the addition of the reactant, and perhaps for a few minutes longer. It is then allowed to stand, or age, for a period varying from 2 to 40 per cent of the gel time. It is during this period that the micelles grow to optimum size for aiding coagulation. Micelle growth is controlled by diluting the treated silicate still further, following the aging period, to an SiO_2 concentration between 0.1 and 0.5 per cent. This final dilution either stops all further micelle growth or slows it down to the point

Fig. 1. Chlorine Activation Unit

Pictured above is a unit for the continuous activation of silica with chlorine. It is marketed under the trade name "WT Silactor" by Wallace & Tiernan, Inc., Belleville, N.J.

where gelation is inconsequential. Sufficient activated silica is usually made at one time to treat the water over a 24-hr period. The numerous drawbacks to such a system include the large size and number of tanks, the multiplicity of pumps, the danger of gelation in the mixing tank, and the possibility of error.

Continuous systems of activation have proved very satisfactory during the past few years. Acid has usually been employed as the reactant, although bicarbonate has been used to some extent. A recent development is the utilization of chlorine in the continuous activation of silica.

Chlorine Activation

In chlorine activation, the sodium silicate is diluted with water containing the proper amount of chlorine, and the alkali is partially or wholly neutralized. The neutralized solution is then aged for a very brief period, further diluted, and fed to the point of use. As the silica does not enter into reaction with the chlorine, but is simply released from the silicate in the form of micelles, all of the chlorine is available (as NaOCl or a mixture of NaOCl and HOCl) for its normal functions. At the point of application, the pH of the sol produced by this method ranges from approximately 7.0 to 8.5.

Because the sol is made and used within a matter of minutes, the need for holding tanks is eliminated. Continuous chlorine activating equipment (see Fig. 1) provides a final solution with a silica concentration of 0.1–0.5 per cent, thus inhibiting further micelle growth and minimizing the hazard of gel formation. A previous article (*1*) has described such activation units, which are simple to operate and have proved their usefulness and reliability at many plants.

Application

The application of activated silica is not complicated, provided one always remembers that it is a coagulant *aid,* not a coagulant. It assists floc formation but will not produce a floc by itself. Thus, it is always used in connection with a coagulant, such as alum or iron salts. In some instances, enough iron may be naturally present in a reduced state to act as a coagulant when chlorine-activated silica is added. The chlorine oxidizes the ferrous iron to the ferric form, and the activated silica agglomerates the oxidized iron into a dense, fast settling floc.

Activated silica has been used in water treatment for many years with excellent results. In several instances, however, it appears to have been of little value and, in one or two, even harmful. Undoubtedly there are some waters that will not respond to activated silica, and there are plants where coagulation is already so complete that it cannot be improved upon. The mere addition of activated silica is not a panacea for all coagulation problems, nor will coagulation always be improved to such an extent that the alum dosage can be reduced. Sometimes it may even be necessary to increase it. Nevertheless, if due consideration is given to all the conditions, the results obtained with activated silica are little short of spectacular, and savings can usually be effected.

Activated-silica dosage is expressed in terms of the amount of SiO_2 added. As each gallon of silicate contains 3.329 lb of SiO_2, it is necessary to add 2.52 gal of sodium silicate to apply 1.0 ppm SiO_2. The usual dosage averages between 3.0 and 5.0 ppm, but, in rare instances, may be as great as 20.0 ppm. Sometimes the activated silica is applied as an arbitrary percentage of the

alum dosage, but it appears to be better to determine the requirements by jar tests.

When making such tests, it seems advisable first to find the two or three alum dosages giving the best results, regardless of plant practice, and then to vary the silica application. The pH of each jar should be recorded, because it plays a very important part in coagulation. If coagulation is attempted outside the usual pH range (4.0–7.0 for alum), activated silica may prove ineffective. It is true that the pH range for coagulation is widened by using silica, but there are limits. In waters with a very narrow optimum pH coagulating zone, however, it can be expected that activated silica will make the process less critical.

The point of silica addition must also be studied. In some waters the silica should be added ahead of the alum, and, in others, subsequent to it. The proper point must be determined for each water. At present, however, it appears that silica application usually follows alum addition. Of course, piping arrangements may preclude choice in the matter. Careful laboratory studies are necessary to determine where concessions can be made to existing conditions.

As previously indicated, the use of activated silica is often, but not always, a means of decreasing chemical costs. Even when it raises them, the improvement in the product or the increase in plant capacity may more than justify the increase. In plants where coagulation has always been poor and where it has never been possible to produce a satisfactory water no matter how much money was spent for chemicals, the application of activated silica is unquestionably warranted. At one Indiana installation, the peak demand for water during a short canning season exceeded the plant capacity. Additions were necessary for this limited period only, unless more water could be processed. The use of activated silica aided coagulation to such an extent that the peak demand is now easily met by the facilities available. In another instance, a New York State paper mill required a water that was colorless and completely free of turbidity. The treatment plant could not produce a satisfactory water unless operated at half capacity. When activated silica was applied, floc formation was so improved that it became possible to operate at 120 per cent of capacity for short periods. Actual chemical costs were increased by $1.00 per million gallons, but the need for plant additions was eliminated. As an unexpected dividend, the continued production of a colorless water saved enough in the paper-making process to pay for the equipment in less than 2 years.

Activated silica is a valuable process in the treatment of water. Several methods of activation are available, including a continuous system using chlorine. The chlorine method has the advantage of drawing both sodium silicate and chlorine from their original containers without intermediate handling. The chlorine used in this process is available for the normal purposes of chlorination. The use of activated silica can widen the optimum pH range for coagulation, lead to the production of a better water, and increase plant capacity.

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Fluoridation at Indianapolis

By Robert J. Becker

A paper presented on Feb. 11, 1953, at the Indiana Section Meeting, Indianapolis, Ind., by Robert J. Becker, Asst. Supt., Purification Dept., Indianapolis Water Co., Indianapolis, Ind.

DURING the early summer of 1951 the Indianapolis Water Co. received a resolution—adopted by the city health board and the city department of hospitals, and endorsed by representatives of the Indianapolis Dental Society—requesting the company to make immediate plans for fluoridation and to present them to the Indiana Board of Health for approval. At the time the resolution was presented, the company was scheduled for a rate hearing before the state public service commission and was able to include the cost of fluoridation in its petition. The rate hearing ended favorably for the company, and the increase granted covered the cost of fluoridation. The utility was then in a position of having an order from the public service commission to proceed to fluoridate the water.

The extent of the preparations made for feeding fluoride seems almost beyond reason in some respects. The Indianapolis Water Co. insures its employees with a company that utilizes one of the local industrial clinics. The newness of the problem for clinic personnel led them to examine thoroughly each employee who would be involved in the unloading, feeding, or handling of the fluoride chemicals. This examination included X-rays of the chest and bone structure, a cardiograph, an inspection of the eyes, nose, and mouth, and a urinalysis. The men who unloaded the chemical were also scheduled for a urinalysis the day following their handling of the material. The feeder operators were required to undergo this test after 90 days of fluoridation. The results indicated that contact with the fluoride material was of minor significance in comparison with the amount of fluoridated water consumed.

Other precautions taken included the issuance of respirator masks, with instructions on their use, and the furnishing of rubber gloves, goggles, and aprons, if desired. All personnel concerned were advised to clean their hands and clothes before meals and were warned against eating in areas exposed to dust. None of the employees seemed to be unduly worried by these measures, and all were soon performing their duties in a routine manner.

The Indianapolis supply is taken from both White River and Fall Creek. Determinations made over several years indicate that the fluoride content of both sources varies between 0.1 and 0.4 ppm, averaging 0.2 ppm. The maximum figure applies only to the White River and has occurred twice in 4 years. Treatment cost estimates were based on increasing the natural fluoride content to 0.9–1.0 ppm. The chemical chosen was sodium fluoride,

primarily because it was the compound used in the experimental work the published results of which were most favorable. At that time, the use of silicofluoride was not as well accepted as it is today.

Sodium Fluoride

The sodium fluoride was delivered in carload lots of 400-lb heavy-cardboard drums of the type often used for detergents. The only visible dust hazard occurred when the head of one of the drums came loose and the contents spilled out. Pans containing approximately 1 gal of water, with a large surface exposure, were set in the boxcar and on the floor where the material was stored. The fluoride content of these water samples showed only a 0.1-ppm increase, which was good evidence that little dust was present during the drum handling, thus corroborating the results of the urinalyses.

Both the Fall Creek and the White River plant used gravimetric feeders in which a connecting rod moves a scraper back and forth across a stationary tray to displace material from it. The length of stroke of the scraper is adjustable, but there is no nonflooding device. The material falls into a wood-lined metal tub of water, from which the fluoride solution flows by gravity to the postfiltration point of application. The machines are mounted on scales that weigh only the chemical in the hopper, and not the water in the solution tub. The storage hopper on each machine holds approximately 250 lb. The daily volume of sodium fluoride feed at Fall Creek was approximately 300 lb, and that at White River 800 lb.

A mercury switch affixed to an arm resting on the feeder scale beam sounds an alarm and stops the feeding operation when a set amount of fluoride has been discharged. In normal operation, the material is weighed in the hopper every 2 hr, and the counterweight is adjusted so that the scale beam will move from the overloaded to the underloaded position in 2 hr. Should the machine deliver its load in less time, it automatically shuts down and the alarm sounds until turned off.

Each feeder is equipped with a dust collector, which is used only at the time the hopper is being charged. The collectors are the bag type, drawing off dust from the upper extremity of the hopper, filtering it through the bags, and exhausting to the outside atmosphere. In loading, a scoop is used to fill a 2-gal bucket with material from the drum, and the contents are then dumped into the hopper. It is believed that this method, though cumbersome, minimizes the dust hazard.

The feeder performance with sodium fluoride was good, and the material was easy to handle. During a 4-month period of use, the chemical did not show any tendency to pick up moisture or to cake, and the dust problem appeared to be minor.

The weight checks on machine delivery that are made every 2 hr give sufficient evidence of the uniformity of treatment, and whether or not the desired residual is being maintained. Nevertheless, fluoride determinations were made in all parts of the distribution system during the first 2 weeks of treatment. Now readings are taken only on the effluent of the two filter plants, the primary and booster pumping station discharge, and the two elevated tanks.

Before fluoridation was started, the utility occasionally received inquiries about the fluoride content of the water from persons taking the substance under medical prescription. Consequently, it was decided to acquaint the

public with some of the facts about fluoridation and to publicize the actual date for beginning treatment (Aug. 2, 1951). Owing to this indoctrination, less than a dozen complaints attributed to fluoridation were received.

The only difficulties experienced with sodium fluoride were due to the formation of a calcium fluoride precipitate in the discharge lines. This precipitate is initially gelatinous but eventually becomes quite hard. Both plants originally had ejectors in the discharge line immediately below the solution tubs. After a short period of operation the ejectors were removed, as they became a source of buildup of the calcium fluoride deposit, a process apparently accelerated by turbulence. From then on, the solution was delivered by gravity to the point of application. At the Fall Creek plant, the 3-in. diameter of the 50-ft galvanized-iron discharge line was reduced to 1 in. in 4 months' time by the calcium fluoride scale. The White River plant, which had a 400-ft long, 1½-in. rubber discharge hose, encountered similar troubles even more frequently. This condition was considerably relieved by substituting a 3-in. cast-iron pipe and blowing it out occasionally.

Sodium Silicofluoride

On May 1, 1952, sodium silicofluoride feeding was begun at the Fall Creek plant. A new concrete solution tub was built, and the discharge line was changed to a 3-in. reinforced rubber hose with hard-rubber fittings. No alterations were made in the feeder. There have been no difficulties with this treatment.

Sodium silicofluoride feeding was instituted at the White River plant on Nov. 17, 1952, using an entirely new setup. The solution tub and discharge line were similar to those at Fall Creek. A converted carbon feeder was installed and is now operating satisfactorily. At neither plant is a great effort made to dissolve the material. The plan is to use the solution water as a vehicle to transport the fluoride to the point of application as quickly as possible. This procedure has been successful to date. At the end of 9 months no corrosion was evident in the solution tub jets.

The fluoride determinations are made by a modified Scott method, which requires fresh standards to be prepared daily. Preparation of the standards is not particularly difficult, but the 1-hr period needed for color to develop after the reagents have been added is inconvenient. Moreover, the colors indicating the presence of fluoride are a series of yellows which are rather hard to distinguish. The same person should make all readings, so that any tendency to read high or low will be consistently in the same direction. All samples must be dechlorinated before determinations are made. A color disk comparator has not been used.

Chemical Costs

The price of sodium fluoride in boxcar quantities was $11.76 per 100 lb. The cost of application averaged 11 cents per person per year. Sodium silicofluoride, also in boxcar quantities, is $7.69 per 100 lb, and its cost of application averages approximately 5 cents per person per year (based on 110,000 services and assuming three persons per service). The application cost figure includes only the expense for the chemical. The costs of operation and maintenance of feeding equipment, laboratory tests, and other items are additional.

Looking Back—and Forward

By Ellsworth L. Filby

Excerpts from an address presented on Mar. 30, 1954, at the Southeastern Section Meeting, Greenville, S.C., by Ellsworth L. Filby, Engr., Black & Veatch, Cons. Engrs., Kansas City, Mo.

ONE of the earliest training problems given an engineer is to survey an area. He is taught to set up a transit, to take a backsight and then a foresight. This most welcome opportunity to meet with many old friends from South Carolina and Georgia is indeed fortunate, as it permits me to take a backsight on the early health department days and also to speculate on the future. Let us see if the problems of the past have any bearing on the future.

One cool day in December 1917 the Southern Railway dropped a young embryonic engineer at Augusta, Ga., to work with the Red Cross on extra cantonment sanitation about Camp Hancock. Being a damyankee from New York, I was off to a bad start, but, as the Pennsylvania National Guard was encamped in tents at that winter resort, I was accepted. It got cold and still colder, and all the water service pipes coming up under the houses froze and burst. The Augusta filter plant—tub filters, if I recall correctly—could not meet the tremendous demands. Some US Public Health Service personnel and the author rigged up a number of barrels, requisitioned lots of hypochlorite, and treated the settled Savannah River water, which was then bypassed without filtration to the distribution system. The gods smiled on us, for, although the coliform index of the distributed water was very high during the next 3 or 4 months, no enteric disturbances were noted.

South Carolina Experiences

In 1919, having been discharged at Camp Jackson, I was given an opportunity by James A. Hayne, the state health officer of South Carolina, to do pioneer work with water works men and sanitary officials to prevent waterborne disease and to further good operation of water and sewerage utilities. Problems then were just as tough as they are today. Columbia was having a typhoid outbreak that the US Public Health Service thought was waterborne. The theory was that contaminated water was seeping into the supply through cracks in the sand filters. Strangely, though, not one typhoid organism slipped through the single pipeline to the Pacific Mill village area. By sheer luck, we stumbled on a possible carrier—a dairy employee who occasionally helped bottle raw milk. He gave a most circumstantial history of "malaria" that had all the earmarks of typhoid. Although his stool tests were negative, he was dismissed by the dairy, and no more cases appeared.

Red worms in the water at Conway were identified as midge larvae, re-

garded as an indication of sewage pollution. But Conway had a deep, free-flowing artesian well, and the nearest sewer was 30 miles away! The town had an open distribution reservoir, however, which suggested the cause and the remedy: clean and cover the reservoir, screen all openings, and flush out the mains. The red worms vanished.

When Newberry's deep wells began to fail, we had to rig up an emergency surface supply. The city cleaned up all the open privies along a nearby creek, built new ones of the can type, constructed a small timber dam, and set up a pump. We unpacked the first emergency chlorinator ever used by any state board of health, set it up, attached a cylinder of gas, turned on the machine, and—no chlorine feed. We tore the chlorinator apart, including the head diaphragm, and cleaned out the grease. It took several tries to get it back together again, but finally it worked. The mayor looked the chlorinator over and approved its use, remarking that "I sure wouldn't let you use the old Army Lyster bags or those barrels of solution they doctored the water with in the Army!"

Industry, which was just discovering the South then, found that the Piedmont hills had a plentiful supply of excellent soft water, although the turbidity was high. Lockwood, Greene and Co. of Boston, Mass., asked our advice on a site for a new bleachery, and we helped put Lyman, S.C., on the map—almost entirely because of its water supply.

In those days the health department was issuing a mimeographed, correspondence course type of publication called "Sewat" ("sewerage and water"), the forerunner of the Clemson College short courses and the present excellent periodical, "Out of the Spigot." We tried to knit the water works fraternity a little tighter together and to tell of some of their accomplishments. We didn't refer to "public relations" then, but we did dislike the inherent modesty of water works men.

Before leaving the past, I should pay my deepest respects to men like Guy White, Robert B. Simms, John Hawkins, Francis McDowell, Victor Gaffney, and all the others who have carried on the good work, who have guided the destinies of their communities, and who have earned the confidence and regard of their fellow citizens. No man can ask a greater reward.

Water Supply Problems

Turning to the future, what can we see on the dim horizon? Ground water levels have been dropping for several years as catchment areas become denuded of vegetation and are put to farm or commercial use. A state senator once described the artesian wells in the timber belt of the South Carolina low country as "God's gift to mankind," and promptly voted to kill a bill that would have required abandoned free-flowing wells to be capped or plugged. Water is a valuable resource that can easily be wasted. Once it is gone, it is most difficult to restore. Its use should be planned, so that our grandchildren may be able to enjoy this fair land.

Supply from surface streams is fast becoming a matter of feast or famine—floods or droughts—with the normal flow ever lessening. For the city on a small watercourse, the sign is clear—danger ahead! The federal government must combine flood control with

regulated discharge, while doing its utmost to prevent the siltation that has ruined early-day reservoirs. Perhaps the answer will be the impounding of mountain streams and the organization of large water supply districts. Greenville, S.C., provides an excellent example of progressive action; already it is studying methods of increasing its supply and is serving not only its metropolitan area but also communities as distant as Fountain Inn and Simpsonville. Perhaps, in time, transmountain diversion will be permissible in the East, as it is in the Rocky Mountain states, and water supply districts or authorities will transport raw water to member cities. Quantity will be a most important consideration in the future, and the wise water works man will observe the Biblical adage, "I will lift up mine eyes unto the hills, from whence cometh my help."

Quality is another consideration. How do the wastes of today and those of the future affect us? In 1919 South Carolina had a law prohibiting the dumping of cottonseed into the waters of the state. As a result, its producers discovered its value as a byproduct. Many other wastes can likewise be processed, often profitably, and they will be, just as soon as water works men and the state stream pollution authorities enforce strict controls. Sewage pollution can generally be handled satisfactorily by well established methods, although future developments may plague us even as the present widespread use of synthetic detergents affects the small receiving stream and the downstream water plant.

Manufacturing processes are changing almost daily, and their waste chemicals may seriously affect the potability of the stream for many miles. The alert water works man and the state authorities must be cognizant of developments on watersheds and should, perhaps, close certain areas to industries producing specified wastes. You cannot rest on your oars and drift along—today's waste may be of no moment, tomorrow's may ruin the water supply use of the stream. Preventing such situations is better than rectifying them after they have come into being. Perhaps all streams should now be classified by use and reserved for such utilization regardless of the pressure for more payrolls and more industry. Prevent desecration of our streams, going to court, if necessary. The Kentucky supreme court has held that this is possible and right. And because you use wells, don't sit back smugly and say, "It can't happen here." Out West, the US Bureau of Reclamation has fostered land irrigation that has gradually made the ground water very hard and chemically undesirable for domestic use. It seems wise to get complete chemical analyses of each stream and ground water supply at least twice a year, in order to chart quality changes. Review previous analyses to see how changes slowly but surely have come about. Unfortunately, the changes are almost always for the worse.

Water conditioning, which, in the South Atlantic region usually involves turbidity or color removal and corrosion control, will be more and more important in the future as industry demands better grades of water, specific temperatures, and so forth. Some of the deep artesian supplies may carry hydrogen sulfide and hardness, which will be removed. But turbidity and color removal, along with taste, odor, and corrosion control, will be the major water-conditioning problems of the future. Perhaps Guy White's suggestion of 1920 will bear fruit: "Some of you

engineers ought to figure out a way of changing the electrical charge on turbidity so it will all settle out in the basins and we won't have to use alum." Today we deionize water and demineralize it electrically. Perhaps some inquisitive water works man and electrical wizard will show us how easy it is to remove turbidity by that means.

Personnel Recruitment

Who will run the water works of the future? Someone has said that today's water works men are old and too few replacements are in sight. Young men can be *recruited*, however, not merely hired, and then trained and pushed up the ladder of success. The smart superintendent knows he cannot carry the full load in this complex age, certainly not forever. If you train these youngsters right, you will receive their unstinted support and admiration; they will be loyal and always ready to pitch in with the enthusiasm and vigor of youth that soon gets the hardest problem solved. A superintendent today is a manager—a director, if you wish—who has built up a staff of assistants trained to do the routine work and bring reports and records up to date. Thought should also be given to the employment of women. They can run a front office, meet the public, do laboratory work, make maps and drawings, and even read meters, as they are doing for one private water company I know of.

Industry today recruits its future personnel in the early college years, and often in high school through the lure of college scholarships and job opportunities. Why should not the larger water works do the same? You may hear (you should know) that Meter Reader Jim's lad wants to go to engineering school, but the costs are beyond Jim's purse in these inflationary days; why not call Jim in and mention your willingness to finance part of the lad's schooling if he will work summers for the water department? Perhaps, for a few hundred dollars, you can obtain a good man, and, if you have the lad interested, you can find the money somewhere. There are scores of help funds available, if you will only look around for them. And, if, after three summer work periods, you have not sold him on the desirability of public service, then you ought to brush up on the subject yourself. You will have to recruit personnel in the future—better start now.

Joint Operation

There is a trend toward broadening the responsibilities of the water works executive to include other municipal services—sewerage, garbage disposal, and perhaps gas and electricity, if these utilities are municipally owned. Combining water and sewerage utilities under single management has much to commend it. The water works man takes raw water, conditions it, and delivers it. Why shouldn't he also carry away the used product, recondition it, and make it available for his downstream neighbor? Who is better qualified by training and experience with pollution problems to do it? With revenue bond financing of construction funds, there is no reason why water and sewers should be under separate management. Consolidation is just economic good sense.

Preparation for Emergencies

The future may bring natural or manmade disasters. Are we in the water works industry ready for them? Mutual aid programs should be quietly prepared and fostered, so that, when

disaster strikes, as it did in 1951 in Kansas City, we will not be caught napping. The water department manpower and material reserves of every community should be known to its neighbors. How vulnerable you are to sabotage is another question you should ask yourself.

Water works men can effectively prepare for emergencies if they will devote a little time, with their key staff members, to studying eventualities. What happens when an explosion or fire puts your main high-service pumping station out of action; when a conflagration cannot be checked and fire trucks are summoned from nearby communities? Will these pumpers need adapters to use your hydrants? Can you close large valves rapidly enough to prevent water hammer and still get more water quickly to the stricken area? In Kansas City, certain major distribution valves could not be closed, and treated water was added to the flooded areas while other parts of the city had insufficient volume. When the fire chief complains of lack of water, can you produce recorded data to disprove this alibi?

With the present-day widespread use of all sorts of industrial chemicals transported by truck or railroad, a spill or wreck may pollute a watercourse so that you dare not use it as a source of supply. Would you "read about it in the papers," or are your communication lines such that you would be alerted at once? Do you know the disaster hazards in your city and its environs? By the way, who takes over when you awake in a hospital after an accident or sudden illness? A chain of command should be set up to insure that service will continue.

Testing New Ideas

What can you do to help the water works men of the future? Keep alert, and be willing to try out the ideas of your staff. Question present-day theories and practices. For example, why does the water department read meters, the gas company read meters, and the electric company read meters? Why not combine all three into a single reading unit, complemented by a multiple collection service with branches scattered throughout the city or service area? Why must you mail a check or go to the city hall to pay a water bill, when you can pay gas, electric, and telephone charges at neighborhood stores or banks? Why should water meters record only the volume used; why not also the rate of use, the demand? Someone will come up with a simple gadget to do this—perhaps someone in your department.

Tomorrow is but today once removed. The future is in your hands to mold as you will. Keep your eyes on the stars and move forward, remembering that each one of us can add a bit to the foundation on which future water works practices will rest. We inherited a good past—will we bequeath the same to our descendents?

Improvements in Operation Through Better Administrative Practices

By M. J. Shelton

A paper presented on Oct. 28, 1953, at the California Section Meeting, San Francisco, Calif., by M. J. Shelton, Gen. Mgr. & Chief Engr., La Mesa, Lemon Grove & Spring Valley Irrigation Dist., La Mesa, Calif.

THE water works manager normally looks to the customer and taxpayer for additional income to meet the continually increasing expenses of operation. The reduced purchasing power of the dollar and the growth in water demand since the end of World War II have combined to make this basic problem more pressing than ever. Many utilities have tried to get along on their old rates, reducing their expenses by eliminating certain services formerly rendered and by postponing maintenance and replacement. This apparent economy actually becomes a greater burden as time goes on. Still, the necessity of raising rates is a difficult one to face, and, in the presence of adverse public reaction, the governing body usually postpones the increase. The La Mesa, Lemon Grove, and Spring Valley Irrigation Dist. has been confronted with such a problem, and the purpose of this paper is to describe how improved administrative practices have enabled the district to give service without raising rates, despite a tremendous rise in demand.

The district, which is located to the east of and adjacent to San Diego, Calif., contains 22,651 acres, including a population of 67,000 in 1952—more than 5½ times the 1940 figure. As a result of this urbanization, the district has been forced to convert its operations from irrigation to domestic water supply.

In 1945 the district had one engineer, its manager. Problems brought about by the rapid growth made necessary the addition of qualified engineers, so that operations could be analyzed, additional records developed, and facilities properly designed, on the basis of adequate data. From time to time the district board of directors has established additional rules and regulations resulting in higher standards, equitable division of costs, improved public relations, and greater personal efficiency. In 1951 the board employed an administrative consultant to make a study of office procedures and recommend improvements. The report was submitted in June of that year. Nearly all of the recommendations have been adopted, and many other changes have been made. The cost of the survey was small, particularly when compared with the tremendous benefits that have been realized.

Shortly after completion of the administrative survey, the position of business manager was created. He

works closely with the general manager, being responsible for administrative details such as personnel, accounting, billing, purchasing, warehousing, office procedures, and customer relations.

It was determined at the outset that a given procedure or operation would not be accepted as necessary merely because it was long established. Starting with the most flagrant deficiencies, changes were brought about within the office and in the field, and even basic policies of the board of directors were reviewed. In consequence, duplication of records has been eliminated; greater labor efficiency has been achieved through motion studies and increased machine operation, with a resulting reduction in both field and office personnel; extension policies have been improved; a clear-cut budget control procedure has been adopted; an entirely new system of map records has been instituted; suggestions from employees have been encouraged by awards for those accepted; and, most recently, a pension system has been instituted, providing additional employee benefits that will still further decrease an already very low labor turnover. Some indication of the monetary value of these changes is given by the fact that the cost of water delivered to the consumer dropped from 17.2 cents per 100 cu ft in 1948 to 14.0 cents in 1952. During this period the district was also replacing many obsolete pipelines and generally improving water quality, quantity, and pressure—actually at a pace greater than the growth of the population.

Technological advances are facilitating, and changes in public attitudes and demands are constantly requiring, higher standards and better service. In such circumstances, obsolescence is normal, but it may arrive more rapidly than expected. The problem of management is to establish methods of detecting it, to maintain alertness, and to revise operations and procedures as appropriate.

Organization and Personnel

As previously indicated, the district is governed by a board of directors, consisting of five men whose terms are staggered. Elections are held every 2 years and the members serve for 4 years. The board operates in the same manner as a city council, under a section of the California water code governing irrigation districts. An assessor-collector-treasurer is also elected, and the board appoints an attorney, secretary, general manager–chief engineer, and business manager. The rest of the employees in the organization are hired by the latter. All operations are carried out on a 40-hr week basis, including those of emergency crews. Overtime is held to an absolute minimum.

Engineering has played a most important part in the district's activities in the past few years because of population growth in the area. That department has, therefore, been enlarged, whereas all others are actually smaller than they were a few years ago. Although the number of accounts has more than doubled since January 1948, the district has added only one employee to the main office staff and one to the outside force.

One of the first steps taken was to review the existing salary schedule to see that it was reasonably in line with that prevailing in other public bodies in the area, making due allowance for such differences as the absence of a

pension system for district employees. After 1951, when district employees were first covered by the Federal Social Security System, it became feasible to establish a retirement system, which had previously been precluded by the large number of employees with long service. Such a plan was initiated in 1953, with 95 per cent participation on the part of those eligible.

The district now follows a general policy of employing younger people and tries to obtain college men for the more important positions. Experience has shown that the additional amount paid for a better qualified person is more than offset by his greater effectiveness and adaptability.

An innovation started in 1951 was an employee grading and interviewing system. Each foreman grades his men in every 6-month period, and his report is reviewed by the superintendent, who makes notations before turning it in to the business manager. The latter then personally reviews the grading sheet with the employee in a private conference; in addition, he asks for any criticisms or suggestions that the employee might have. These interviews have been most beneficial in improving personnel relations and developing better operations. Upon completion of the reviews by the business manager, he meets with the superintendent and general manager to go over each man's record and determine whether he is to be recommended for an increase in salary. The recommendations are then presented to the board of directors for formal action.

Office Rearrangement

An early change was the complete rearrangement of the office. In the past, there had been an aisle down the middle of the office, dividing it into two parts. On one side was the "water department" and, on the other, the "tax department," each with its own counter and collectors. The result was that the public would often call at the wrong department and have to be referred to the right one, making for lost motion on the part of an employee, as well as inconvenience to the customer. Even more important was the fact that the employees of one department were never used to relieve the work load in the other.

Under the new arrangement, the two departments were combined into one. Small separate offices were eliminated and the business manager was located at the rear center, where he could oversee all activities. The counters have been attractively redesigned, and the telephone switchboard is now situated near the main entrance, so that the operator can also serve as information clerk. Full use is made of the time of all employees, work assignments being given out by the chief clerk. In accordance with the findings of motion studies, desks have been so placed that a person takes as few steps as possible to perform his job. Maps are easily accessible to both the public and the employees. A drinking fountain formerly installed at the rear of the office for personnel use has been moved to the front, so that visitors can drink the water which is delivered by the district —a worth-while public relations device. A single clerk has been placed in charge of a central file, thus minimizing the possibility of misfiling while greatly cutting down the time consumed in locating documents.

Each person in the office is assigned a primary function but works at other positions for a sufficient time to become

thoroughly familiar with them. This policy of understudies for all operations has been applied in every section, both in the office and in the field. A written job description, describing all functions or duties, has been drawn up for every position, thereby further insuring continuity of action in the event of absence of an employee.

Forms

The administrative survey had indicated considerable duplication and lack of coordination in the preparation and use of forms. The business manager obtained a copy of every form in use and began a study to see whether it was necessary, what was done with the information, who received it, and whether it was temporary or permanent. Interviews were held with the persons who regularly initiated or received the form to determine if it could be eliminated, combined with others, or simplified. The number of forms in use was reduced materially, saving labor, time, and filing space.

Standard Procedures

As the administrative modernization got under way, it became apparent that there should be a permanent system of advising all affected persons and at the same time making available for the future a ready reference source on policies and procedures. This was accomplished by the issuance of executive orders, standard practices, board memoranda, and the like. Department heads receive copies as issued and place them in a loose-leaf book, where they are easily accessible.

Machine Operations

Before the administrative survey was made, the single billing machine on hand had to be operated overtime to keep up with the billing schedule. A review of billing practices simplified the work, eliminated some steps, and made possible the preparation of all bills well within regular work hours. The meter reader's sheets were revised to assist both him and the billing-machine operator. The bulky, large-size individual water account cards formerly kept on permanent file have been eliminated. Billing data are now printed on a small card simultaneously with the customer's bill. The cards are destroyed after a year, as a permanent record is still available in the meter book. Calculating machines, typewriters, and other such equipment are replaced on a regular schedule in order to obtain maximum efficiency.

A wire recorder, acquired to save stenographers time in taking dictation, has also proved valuable for recording telephone calls and conference discussions. A photostat machine is used to make copies of maps, letters, and other documents, and a blueprinting machine in the engineering department can likewise be employed for this purpose.

Improvements in machine operations were not limited to the office, but were made in the field as well. In this connection, the board of directors' policy of awards for suggestions has proved fruitful. A wagon drill has been adapted for drilling services under roads, with very great savings in time, labor, pavement repair, and inconvenience to the public. A small service trenching machine was developed, and study is being given to a drill that will permit the placement of a new copper service inside an old galvanized-iron pipe.

Collections

It has always been recognized that peaks in office routine should be eliminated. To this end, the district has for years contracted with banks and drugstores to serve as collection stations. This policy has been extended to include express offices, which will receive payment at any of their branches, regardless of location. All bills carry a listing of the collection stations, as well as a note recommending payment by check. This campaign has increased collections through these media, so that the growth in the utility's business has not necessitated adding more tellers at the office. In fact, the number has actually been reduced by one, as a result of the office rearrangement.

Calendar Check List

The job descriptions mentioned earlier indicate when a certain report is due, when contact is to be made, and the like. As a further safeguard against oversights, the business manager maintains a calendar of such items. Related matters, such as fire and property damage insurance, are now attended to on the same date, if practicable. The business manager, through the chief clerk, reminds the persons concerned well in advance of due dates.

Budget

Although, in the past, an annual projection of expected revenues and expenditures was made by the district, no true budget was prepared. It is now the responsibility of the business manager to coordinate the efforts of all departments in the preparation of such a budget and to maintain control throughout the year. Every department makes a careful study and tabulation of the anticipated work, giving costs and justifications. This information is brought together by the business manager, who, after thorough analysis, reviews it with the general manager. The entire budget study is then presented to the board of directors and examined in detail with them at meetings held during June. After final adoption by the board of directors, the budget is used as a guide in authorizing construction projects or purchases involving capital outlay as they come up. Two years of experience with this procedure indicates that all department heads cooperate fully, that there is improved coordination in the planning of projects, and that less work is performed and charged to so-called maintenance accounts, resulting in very substantial savings.

The district system still has many miles of substandard pipe in service, acquired from existing utilities when the district was formed. This condition, together with the very rapid development of the area, often necessitates unanticipated expenditures. Consequently, the budget includes a considerable fund to meet such situations.

Communications

For a number of years, the district has maintained six radiotelephone-equipped cars, this utility having been one of the first to take advantage of the service when it was introduced by the telephone company. With expanding operations made necessary by the growth of the area served, it was determined to increase the number of radio-equipped cars to a total of twelve. A thorough study showed that twelve three-way radio units would approximate the cost of six additional radio-

telephone units installed by the telephone company (based on a 10-year life, with full allowance for maintenance, depreciation, and other expenses). The principal argument for conversion to three-way radio was the fact that the radiotelephone channels had become overloaded, often causing long delays. Although a radio unit is not in contact with all land phones, this disadvantage is offset by the ability to hear the conversations of all other units and thus keep abreast of the situation. Furthermore, the radio cars can communicate not only with each other but also with the telephone operator at the base station, who normally handles customer calls.

Emergency calls from customers during off-duty hours present a problem. In the past, the district listing in the telephone book included the home numbers of all emergency personnel, as well as the superintendent. The result was that a customer often had to make several calls to reach an employee on standby duty. Retaining an employee at the office or shop at all hours would have been far too expensive, and it seemed impractical to have the police receive the calls. The solution adopted was to arrange for all off-hour calls to be taken by an answering service, at a cost of only $25 per month. The district informs the answering service of the names, responsibilities, and telephone numbers of men on standby duty, so that the telephone operator can get in touch with the right person, depending on the nature of the complaint. In this way, off-duty men get their rest and the customer has to make only one call, which is handled by a trained operator. This service has been in effect since the beginning of 1953 and has proved to be very satisfactory.

Leasing of Automotive Equipment

Detailed analysis indicated that the district might be able to lease automotive equipment at a saving over the former plan of operating its own fleet and shops. After considerable negotiation with a number of possible bidders, the district contracted with one of the local dealers for 29 vehicles, ranging from sedans to flat-bed and dump trucks. The sedans and pickups are furnished on a 2-year replacement basis, the larger trucks on a 3-year basis. The dealer makes all mechanical repairs, supplies oil, batteries, and tires, and services the vehicles in the district's yard at the close of the day. The district furnishes gasoline and insurance only.

The benefits from this program are numerous: the district always has a modern fleet, which makes a good impression on the public; delays due to repairs are at a minimum; labor time equal to that of 4½ men is available for other purposes; the shop need be used only for preventive maintenance on heavy construction equipment; administration by the management and superintendent has been eliminated; purchase orders have been reduced one-third; and inventories of repair parts and tires are unnecessary, thereby releasing funds for other projects. All this has been accomplished with the same cash outlay as was required by former operations, but funds previously tied up in capital have been released for water main installations. A further advantage of the new procedure is that the costs are known in advance for the entire year, payments being made monthly at a fixed rate per unit. It is planned to place all automative equipment, except that for heavy construction, on a lease basis within the next year.

Distribution System Records

Conversion from irrigation to domestic service has brought about many changes in the district's distribution system, which, in turn, have necessitated the development of a master plan that is annually reviewed and amended to meet new conditions. System records are the full-time responsibility of one engineer, who checks all facilities installed and keeps up with current construction. Drawings and descriptions are prepared to predetermined standards and are filed and indexed for ready reference. The photostat machine is used to reduce record drawings to the proper scale, and additional data are drawn on the prints. This procedure eliminates 75–80 per cent of the drafting work and expense.

To replace the cumbersome and sometimes inaccurate maps that have been maintained since the inception of the district in 1926, a map-making project was started in July 1952. All base sheets are now completed and in use in the tax department. New wall maps are also in use, and pipeline data are being recorded on a second set of tracings. Meters are located relative to property lines; the size and type of service, the account number, and the address are shown; pipeline data include the date of installation, size and type of pipe, work order number, and location relative to centerline. Elevations are shown wherever such data are available, and eventually it is planned to include contours. Full use of the photostat machine has been made in reducing layout time by bringing record maps into the proper scale, so that they can be traced.

An attempt was made to contract the entire project, but none of the regular map-making companies was interested and one local engineering company's bid was so much higher than the estimated cost that the board of directors authorized performance of the work by district forces. The project is set up as a special department, removed from other activities, so that the work can be carried on without interruption. To date, progress and costs have been well within the estimates.

Extension Policies

The board of directors has established basic policies pertaining to granting of service to customers who do not front on pipelines, as well as regarding the installation of facilities in new developments. In the former, the district requires the owner to sign an agreement stating that, when and if a pipeline is installed, he will pay front-foot costs based on 6-in. pipe. The document is recorded, and each prospective owner of property so covered is informed of his responsibility whenever a title search is made. Upon the signing of such an agreement, temporary service is given from the nearest main.

Whenever an individual or developer inquires about new pipelines, the engineering department prepares a cost estimate and makes a schematic layout indicating the size, location, and type of pipe, and the location of valves and fire hydrants. This information is shown on a printed form, which is furnished to the person inquiring, with copies being placed on file. The owner must employ a private engineer and contractor, as the district does not do any construction itself, with minor exceptions. Payment of the estimated cost must, however, be made to the district before work can start, and the

owner has to send the district a form letter stating the name of the contractor, the amount of the contract for installation, the expected date of starting and completion of the job, and the name of the party to whom the district is to make payment. Thus, the contractor is assured of payment, and the work is performed according to plans approved by the district. Any funds not needed are returned to the owner upon completion and acceptance. The district makes spot checks to determine that the facilities are installed as planned. The district disinfects the new lines and makes the connection to the system. All other work is done by the contractor, including excavation for the district main connection. By following this policy of having the owner finance the extension himself, the district can conserve its funds for necessary projects.

The results of the administrative changes described have been gratifying, but a constant search for means of further improvement is being maintained. It is hoped that other utilities will find application for some of the measures that have benefited the La Mesa Dist.

Use of Borax Herbicide at Hydrants

By Roy M. Smith

A contribution to the Journal by Roy M. Smith, City Engr. & Water Supt., Hesston, Kan.

THE presence of tree roots at the base of fire hydrants has long been an annoying problem at Hesston, Kan. Chemical weed killers like sodium chlorate and copper sulfate, though effective, have the disadvantage of being highly corrosive to metals. Excavating the hydrant installation and pulling the roots out of the drains produced discouraging results, as the vegetation merely grew in again during the following year.

In 1950 the author was informed that Borascu,* a low-priced commercial herbicide, could be used around steel gas lines and fences without damaging them. To investigate the possibility of deleterious action of the compound on hydrant parts, the author undertook a simple experiment. Two quart glass jars with screw lids were filled one-third full of water, and samples of steel, cast iron, copper, brass, and several types of rubber were placed in each. One of the jars contained seven tablespoons of Borascu, the other none. After a year the items in the jar with the borax showed no deterioration, while those in the other jar were badly rusted and corroded.

Although such an experiment is not conclusive, there appears to be no reason why the use of a borax compound should be injurious to a hydrant, provided it is not retained in the barrel more than a few days. Should such a compound be left in a hydrant indefinitely, it is possible that some electrochemical action might take place between dissimilar metals.

Another consideration was the possible effect of the compound on nearby trees. The state bindweed supervisor reported that, although the borax would kill all the vegetation in contact with it, the worst that might be expected to

* A product of Pacific Coast Borax Co., Los Angeles. Inquiry regarding this material elicited the following reply from L. M. Stahler, agricultural research director of that company: "Borascu has a guaranteed analysis of 93 per cent borax, $Na_2B_4O_7 \cdot 10H_2O$, with a guaranteed minimum boron trioxide (B_2O_3) content of 34 per cent. At the present time [the Pacific Borax Co. is] producing a more concentrated form of this popular herbicide, known as 'Concentrated Borascu.' The analysis of this material shows anhydrous borax as 89 per cent, with a guaranteed minimum boron trioxide content of 61.5 per cent. As it has been well established that the herbicidal efficiency of the boron compounds is dependent on the boron trioxide content, it is at once evident that Concentrated Borascu will be almost twice as efficient, on a unit weight basis, as the regular Borascu. In the contemplated use in which you are interested, [the company] would definitely recommend the use of Concentrated Borascu rather than the older product, Borascu. The cost per unit of treatment with the more concentrated product will be markedly lower, due, in large part, to the savings in freight costs."

happen to a tree would be the death of a limb or two on the side nearest the hydrant. Accordingly, in 1951, the author applied a handful of Borascu through one of the nozzles on every hydrant adjacent to a tree.

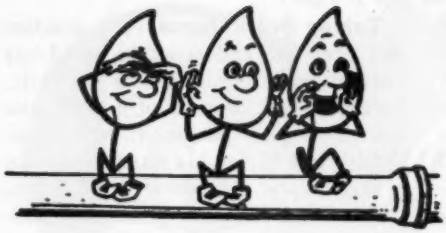
It requires approximately a year for the roots to die and decay sufficiently to be washed out through the drain. The best way to perform the latter operation is to remove a nozzle cap, open the main valve until it flows at full stream (though not necessarily under maximum pressure), close the valve slowly until there is a small continuous flow of water (approximately ¾–½-in. depth in the nozzle), replace the cap quickly, and tighten it. The dead roots will usually wash out in a short time, and the water will come up through the ground near the hydrant.

This method of dealing with the root problem has proved very satisfactory. In fact, the borax-treated hydrants have operated so smoothly, owing to the inhibition of rust and corrosion by the compound, that it is now being used on all hydrants.

Correction

Through a printing error, the first sentence of the third paragraph of the article "Mechanism of Corrosion Inhibition by Sodium Metaphosphate Glass," by James C. Lamb III and Rolf Eliassen (May 1954 JOURNAL, page 445), has been garbled. The sentence should read:

> In 1952 Raistrick (*3*) postulated that the inhibitory action of metaphosphate was due to the formation of a layer of calcium carbonate on cathodic areas.



Percolation and Runoff

What convention? With our three weeks hence your three weeks thence, our Seattle is by now your Chicago. That doesn't leave us much to say about Seattle, except perhaps: "Didn't we tell you so?"—about registration records, scenery, Pacific-Northwestern hospitality we mean. And if your memory isn't conveniently short, just wait till next month when our prattle about Seattle will at last have benefit of the full facts. Meanwhile, get set now for Jun. 12–17, 1955, when the Conrad Hilton (né Stevens) will roll out its welcome mat to AWWA!

Condition Red has always been a sign of danger, but these days when even a blush may be construed as a Malenkov salute, we have real cause for concern over such hair-raising headlines as appeared last month in three different localities of the uneasy East. "Tinted Water Not Harmful," the story of what happened to the water of a large portion of North Jersey when the sludge was blown out of the Wanaque Reservoir transmission mains, was just a wee bit worrisome. "Red Water Annoying" was putting it mildly, at Merrick, Long Island, even though the story was no more than the usual one of rust in the pipes. But what really set us back on our heels was "Water Turns Pinko at Nation's Capitol," the frightening tale of the fountain that gushed red. Isn't that what Joe's been telling us all along about the Executive Branch? And they didn't even have the presence of mind to label it Army blood—just some obvious lying—or was that lyeing?—about a chemical cleaning agent.

We had high hopes of counteracting all this unhappy propaganda with the stirring story of how the French used water (coaxed from the clouds by seeding) as a weapon against the Viet Minh forces besieging Dienbienphu. But after what happened there just a little later, we sort of dropped the idea. Safety, after all, is just a matter of keeping ourselves, our friends, and our water True Blue!

Salt water conversion research projects have been contracted for by the Interior Department's Saline Water Conversion Program with Badger Mfg. Co., which is to work on a radically new type of compression distillation, and Ionics, Inc., which is to do field testing of its electrical membrane process, previously tested in the laboratory. Other contracts had been let

(*Continued on page 34 P&R*)

(*Continued from page 33 P&R*)

earlier with the Polytechnic Inst. of Brooklyn (membranes for selective demineralization), Nuclear Development Associates (high temperature and pressure effects in distillation), and the Bjorksten Research Labs. (economical plastics for solar stills); and a contract is pending with the University of California at Los Angeles.

It is hoped that the Badger work will bring the cost of distilled water down to a fourth of the present level. The Ionics tests will be made in central Arizona and on a municipal supply in the Great Plains, possibly in South Dakota. Improvement of potability and softening is aimed at in the latter test. A final trial may be conducted on municipal and irrigation waters in the lower Rio Grande area.

The salinity control barrier investigation for San Francisco Bay is making use of some choice talents on its Board of Consultants. Arriving from the Netherlands for a two-month tour of duty is C. Biemond of the Amsterdam water works, who is past president of the International Water Supply Assn. Acting as chairman of the board is Raymond A. Hill, a partner in the Los Angeles consulting firm of Leeds, Hill & Jewett and a long-time member of AWWA. The other board members are Charles E. de Leuw, of the San Francisco office of de Leuw, Cather & Co., another veteran member of AWWA; Hans Kramer, retired brigadier general in the Corps of Engineers; Malcolm Pirnie, of Malcolm Pirnie Engrs., New York, honorary member and past president of AWWA; and Philip Rutledge, of Moran, Proctor, Mueser & Rutledge, New York. The project involves water conservation, navigation, urban traffic, city planning, and irrigation.

Taking work home is a practice that everyone endeavors to avoid—as often as not to please the "good" wife. Strange, then, to read of a wife who demands legal separation from her husband precisely for his strict avoidance of home work. Of course, Fred Albro, the husband, is a New York City sanitation worker, and the work he refuses to do at home is bathing. After twelve years, there is perhaps some justification for Mrs. Albro's present action, but justification, too, for Supreme Court Referee Hooley's reserving decision. There are, after all, extenuating circumstances—one water shortage after another—and undoubtedly Fred will now consent to that "need it or not" shower he was saving for their fifteenth anniversary.

Harris F. Seidel has added the water department of Ames, Iowa, to his responsibilities, and is now superintendent of water and sewage treatment. He took on the additional job when Dean Becker, the previous water superintendent, was appointed assistant director of public works.

Ketchikan can't catch enough, apparently, of the stuff that makes it Alaska's and North America's rainest city to keep its citizens supplied with water. Thus, despite a 1953 rainfall of 190 in., public utilities manager John Weir announced on April 1 that the city reservoir was drying up after seven weeks of warm weather, threatening a shortage of water. Just about a perfect example of how lack of water works facilities rather than of water itself can result in shortage.

To make Texans feel just a little better, it should be pointed out that the 190 in. of 1953 was really 40 in. more than normal.

(*Continued on page 36 P&R*)

Crossing the Threshold is An Important Step...

A Threshold Odor Test is the only known way to evaluate your success in removing disagreeable tastes and odors from your water. Frequent odor surveys are essential to insure *constantly* palatable water. Technicians from INDUSTRIAL, *as part of their regular services*, will assist you in the application techniques of AQUA NUCHAR.

The dosage of AQUA NUCHAR—activated carbon—needed to provide palatable water will depend upon the many varying conditions which determine the state of the raw water supply. Waterworks operators realize that partial reduction of odors may not produce palatable water. In fact, the average individual will be fortunate to detect the difference between waters having Threshold Odor values of 50 and 25. Therefore, sufficient activated carbon must be applied at the right time and place to reduce the threshold number to a value of 5 or less. Complete reduction of detectable odors (Threshold Odor of 5 or less) will eliminate complaints and may even result in compliments on the water quality.

INDUSTRIAL'S Research and Technical Group are available to you (without obligation) when you face odor problems.

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(Continued from page 34 P&R)

W. A. Glass, director of the Miami, Fla., Dept. of Water and Sewers, and Alexander Orr Jr., former mayor, at unveiling of plaque dedicating new $2,000,000 water treatment plant named in the latter's honor.

G. A. Fleet, formerly sales engineer for American Well Works, has opened his own office as manufacturers representative, at 175 Orawaupum St., White Plains, N.Y. He will specialize in sanitary engineering equipment.

John H. Sheehan has been appointed sales manager in charge of the Water Works Div., Chapman Valve Mfg. Co., Indian Orchard, Mass. He succeeds the late Donald M. Belcher, who passed away on April 9.

Copper tubing produced by Triangle Conduit & Cable Co. is being labeled with size and type by the use of a brightly colored, pressure-sensitive label on each 20-ft length. A red label is used for Type K, blue for Type L, and yellow for type M.

(Continued on page 38 P&R)

AMERICAN METERS
mean LIFETIME Savings
these 3 ways!

1 FULL REVENUE—highly accurate.
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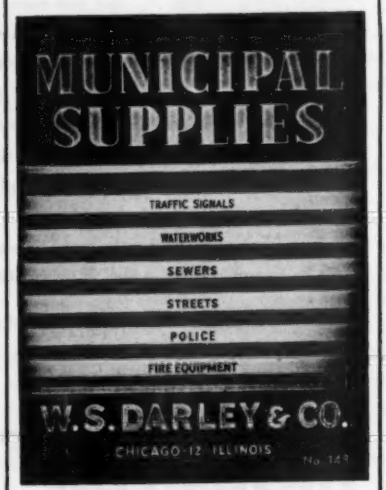

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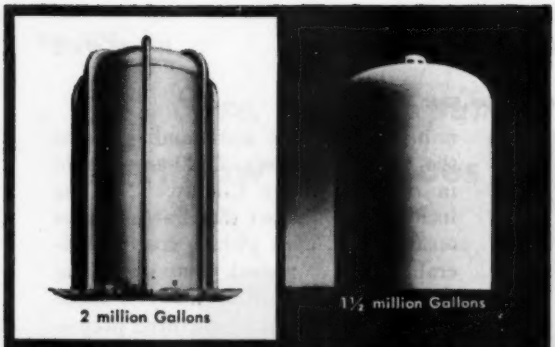
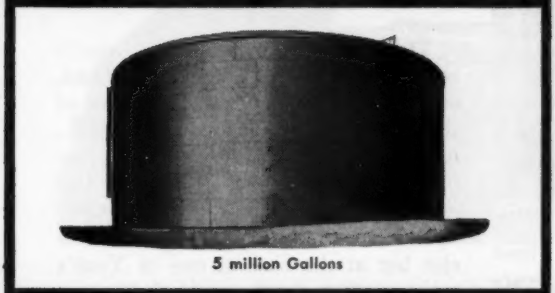


2 million Gallons

1¼ million Gallons

HAMMOND Standpipes . . . Designed to Harmonize with Surroundings.



5 million Gallons

HAMMOND Steel Reservoirs . . . . . Efficient and Economical

when located on ground sufficiently high to produce required gravity pressure—Illustrated is a Hammond five million Gallon Steel Reservoir.

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By the very nature of water supply service, storage tank integrity of design and soundness of construction are absolutely essential.

For more than half a century Hammond has been incorporating these characteristics in all its products — Steel Standpipes • Steel Reservoirs • Elevated Water Tanks • Water Spheres • Filtration and Purification Units for general water supply and fire protection systems.

Hammond Water Storing and Processing Vessels are built to all standard codes and specifications including those of the American Water Works Association, Associated Factory Mutual Fire Insurance Companies, the National Board of Fire Underwriters, the Factory Insurance Association.

400,000 Gallons

500,000 Gallons

150,000 Gallons

100,000 Gallons

HAMMOND Elevated Tanks . . . Double Ellipsoidal, Cone Roof, Radial Cone Bottom and Sphere . . . from 25,000 to 3,000,000 gallon capacity.

Catalog H_2O details and describes all HAMMOND Water Storage and Processing Vessels... Write for your copy.

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(*Continued from page 36 P&R*)

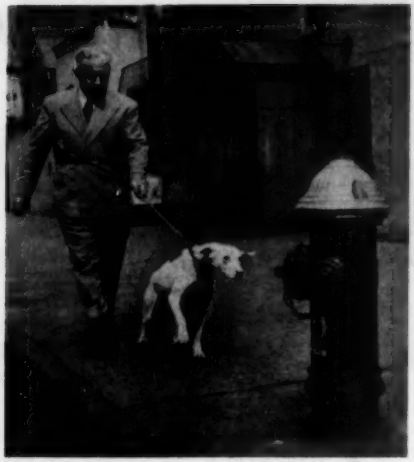

Photo Ira Rosenberg, N.Y. Herald Tribune

That man's best friend's best friend isn't necessarily man appears all too obvious from the above picture of Parees—an imported Italian truffle hound—during his first day in the United States. And well as his intent may speak of the American hydrant, it is hardly the kind of pointing that prompted Gene Leone, famed New York City restaurateur, to pay more than $100 for this valedictorian of his class at the University of Truffle Hounds in Alba, Italy. But if Parees is, after a voyage over a wide and hydrantless ocean, a little too distracted to remember his three gold medals for proficiency in detecting and rooting out those subterranean fungus delicacies which he was trained to unearth, who among water works men will fail to understand? Besides, New York pavement is notoriously rough on truffles.

Incidentally, the structure in the background is not what you think—merely the entrance to Leone's Restaurant, where the product of Parees' pursuit will be served once he gets his mind back on his work and is set to the scent on Gene's 2,100-acre estate in nearby Orange County. No less incidentally, the fact that Parees trains on canned truffles (which cost considerably more than steak) may well bring the price of his normal quarry to about the same as that of his pictured prey—a little high, that is, for a simple supper—even in New York.

That man really is his best friend's best friend is, on the other hand, equally obvious from the placement of the plaque that residents of York, S.C., inscribed to the memory of "Bull, one of the most intelligent, friendly, and affectionate dogs that ever existed" upon his death some years ago. Where else but at the base of one of York's main street hydrants could they properly imbed their tribute to a bulldog who became a friend of everyone in town during his 11-year career as constant companion to policeman and, then, police chief J. Frank Faulkner? Were it his not inconsiderable vocational accomplishments they sought to memorialize, the location would have been embarrassingly inappropriate, but for a best friend they demonstrated their understanding.*

New Central American representatives appointed by De Laval Steam Turbine Co. include Navarro y MacMurray, Panama City, for Panama and the Canal Zone; Maquinaria Universal, Managua, for Nicaragua; Agencias Hegenbarth, San Pedro Sula, for Honduras; and Edward B. Coffey & Co., Guatemala City, for Guatemala.

* Pictorial evidence of this caninity is at the moment unavailable, but the Mueller *Record* for February–March 1954 is full of Bull, from cover picture to the doggonedest detail!

(*Continued on page 40 P&R*)

Sure, that old pump still works,

but how much does it cost to keep?

That rugged old pump of yours may not be the bargain that it seems. Let's do some arithmetic. If the efficiency of the old pump is 75% vs. the 85% efficiency of the new pump, you are paying more to keep it than you would to replace it. That's because a new unit of equivalent output uses less power. Thus it soon saves its own cost—then begins to pay dividends.

Let's take a specific example—a water works pump

Old pump efficiency 84% ..... 625 BHP
New pump efficiency 89% .... 590 BHP
35 BHP Saving

On the basis of 1¢ per KWH, the 35 BHP saving for a 5000-hour year (approximately 14 hours per day) amounts to $1300. This saving, capitalized in 15 years at 5%, adds up to $28,000. Yet the price of the new pump that saves $28,000 is only $4054.

What would the pump replacement profit be in your particular case? Your De Laval representative can tell you exactly—in dollars and cents—as soon as he has the basic facts on your present installation. Call him in today or write to De Laval for Pump Fax Bulletin which includes a valuable "power-savings" chart.

DE LAVAL *Pumps*

DE LAVAL STEAM TURBINE COMPANY

822 Nottingham Way, Trenton 2, New Jersey

DL237W

(Continued from page 38 P&R)

Willis D. P. Warren, retired head of Warren & Van Praag, Decatur, Ill., consultants, died on April 13 at the age of 71. His many activities had included the writing of several books, service with the Illinois civil works engineering board and Civil Works Administration, being president of the Illinois Society of Professional Engineers and the Central Illinois section of ASCE, and, of course, an extensive consulting practice, from which he retired in 1952.

Barada & Page, Inc., of St. Louis has been named to handle cylinder chlorine sales for Monsanto Chemical Co., which has discontinued direct sales of less than tank car quantity. Barada & Page will refill cylinders in the 150-lb and 2,000-lb sizes.

Horace M. Lawrence, in charge of American Standards Assn. projects for building codes, construction operations, materials, and mining, died on April 6, in Teaneck, N.J., at the age of 64. He had been with ASA for 23 years and in that time had contributed to the great advances that have been made in standardization. He was especially noted for his work with the National Plumbing Code, and those in AWWA had reason also to appreciate his efforts on behalf of the A21 cast-iron pipe standards.

Precision Chemical Pump Corp. is the new name for Precision Machine Co. of Somerville, Mass. The firm will continue to produce precision chemical and slurry pumps under its new name.

(Continued on page 42 P&R)

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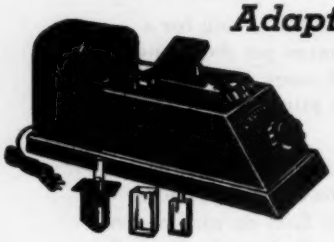

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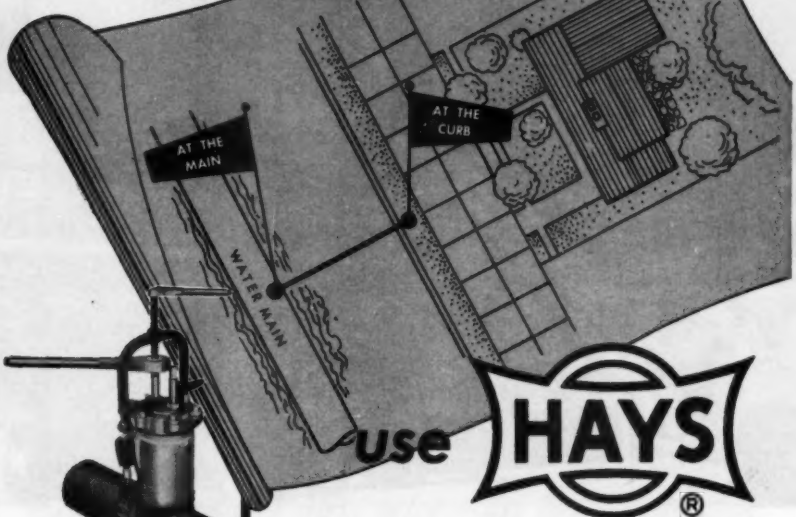

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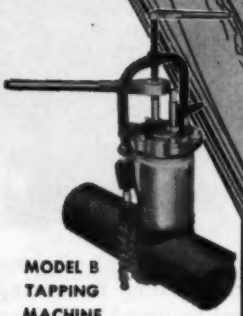

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Water Departments all over the country have been using HAYS Water Service Products for over 80 years.

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WATER WORKS PRODUCTS

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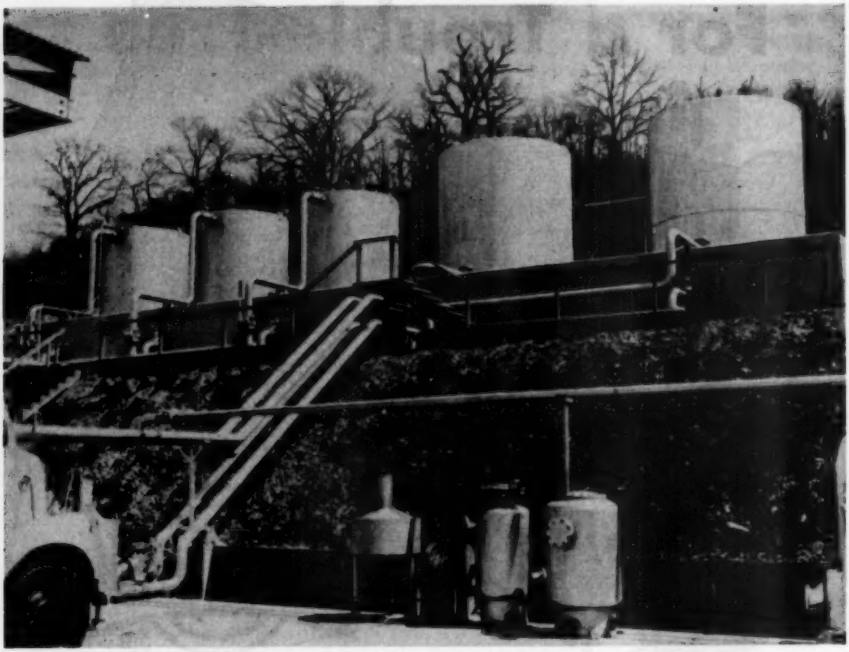
(Continued from page 40 P&R)



A meter and valve test station for checking the performance of products under actual operating conditions has been constructed by Rockwell Mfg. Co. on a site outside of Pittsburgh. Storage tanks (above), piping, pumps, and testing area have been constructed out of doors to permit testing with gasoline and other flammable fluids as well as water. A prover room, machine shop, and control room are housed, however. Various combinations of pumps and piping permit testing flows ranging up to several thousand gallons per minute.

Hugh Glen has been elected president of Johnston Pump Co., Pasadena, Calif., succeeding Mrs. Thomas W. Simmons, who has resigned as president but continues as sole owner of the firm.

(Continued on page 44 P&R)

Filter Sand and Gravel

Well Washed and Carefully Graded to Any Specification.

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Here's one place where cobwebs would be strictly OK—on a piping maintenance man's tools. For the less they have to work, the lower your maintenance costs.

Excessive valve maintenance is serious simply because the average plant has so many valves. So it's sound economics and good business to buy quality and low maintenance rather than bargains and frequent maintenance.

Naturally, the thrifty buyer always chooses quality valves, and for biggest value he insists on Crane. There's no greater assurance of dependable, low-cost performance . . . and the Crane line provides such quality in valves for every need.

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Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

(Continued from page 42 P&R)

A telemetering system designed exclusively to provide automatic remote control of water and wastes equipment has been produced by Automatic Control Co., St. Paul, Minn., under the name "Autocon Telestep." Utilizing a single pair of wires in leased telephone or private cables, the system provides for up to 30 control circuits. Transmitter and receiver units are housed in neat, attractive cabinets. →

Ray L. Derby, principal sanitary engineer of the Los Angeles Dept. of Water & Power, has been appointed to the National Panel of Arbitrators by the American Arbitration Assn. As a member of the panel, he will be available for selection—along with 13,000 other experts in all fields of business—by parties submitting disputes for arbitration.

Type SM Limitorque operating 48" butterfly valve.

LIMITORQUE VALVE CONTROLS

From coast to coast, hundreds of LimiTorque Controls are in service in water works and sewage disposal plants for automatic or push-button operation of valves up to 120 inch diameter. Why is acceptance so widespread? Because LimiTorque Operators are designed to provide dependable, safe and sure valve actuation at all times.

LimiTorque is self-contained and is applicable to all makes of valves. Any available power source may be used to actuate the operator: Electricity, water, air, oil, gas, etc.

A feature of LimiTorque is the torque limit switch which controls the closing thrust on the valve stem and prevents damage to valve operating parts. Write for Catalog.

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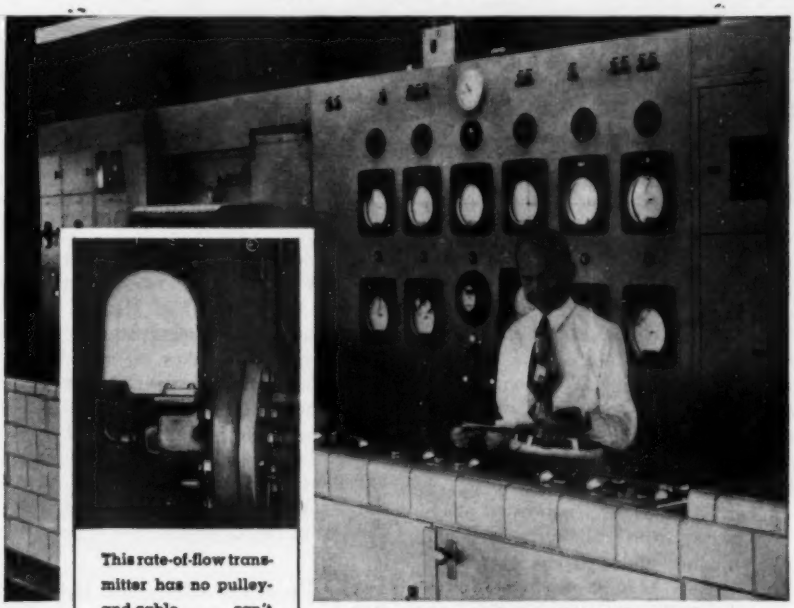

This rate-of-flow transmitter has no pulley-and-cable . . . can't be damaged by over-ranging . . . uses no mercury.

At the St. Louis County Water Company's new $1,500,000 filter plant, Hine, Mo., d/p Cell Flow Transmitters tap differential pressure from venturi tubes in effluent lines of 6 filter beds . . . transmit flow measurement to M/40 Controllers shown on panel above. Controllers hold filtration rates at pre-set control points.

Smoothest-working "TEAM" you can get to control filter rates

Here's an unbeatable team for filter rate control . . . a Foxboro d/p Cell* Transmitter . . . an M/40 Controller . . . and a butterfly valve. It costs less to install and less to maintain!

The d/p Cell Transmitter has no pulley-and-cable . . . no mercury. It detects flow pressure differential across its tough metal diaphragm . . . is unaffected by backwash and sand. The Controller maintains flow at exact pre-set flow rates . . . keeps filtration in perfect balance. The rubber-lined valve provides both flow control and tight shut-off.

Write for complete information.

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FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

The Reading Meter

Legal Problems and Responsibilities in Administering Water Systems. *Ernest H. Campbell. Information Bul. 162, Washington Municipal Bulletin, Assn. of Washington Cities and Bureau of Governmental Research and Services, 250 Smith Hall, University of Washington, Seattle 5, Wash. (1954) 21 pp.; paperbound; free*

This brief but excellent study details a number of areas of legal involvement for the water utility: liability for damages, including those from waterborne disease; service beyond city limits; pressure and supply obligations; flooding; contracts and rates; and similar matters. The exposition and legal references are keyed to Washington experience, of course, but some speculation might profitably be invested in determining how the courts of other states would decide similar situations.

Legal Aspects of Sewerage and Sewage Disposal. *Ernest H. Campbell. Information Bul. 160, Washington Municipal Bulletin, Assn. of Washington Cities and Bureau of Governmental Research and Services, 250 Smith Hall, University of Washington, Seattle 5, Wash. (1953) 15 pp.; paperbound; free*

Among topics considered by this report are the adequacy of sewers, liability for defects or obstructions in them, pollution, construction and maintenance liability, removal of trees, and rates.

Water Works Operators' Manual. *Warren C. Westgarth. Circular 16, Engineering Experiment Station, Corvallis, Ore. (1953) 135 pp.; paperbound; 75¢*

A product of cooperation among the AWWA Pacific Northwest Section, the Oregon State Board of Health, and the Engineering Experiment Station, this excellent manual makes a useful short-course or certification program textbook. In addition to information on water works practice, given in question and answer form, the book is furnished with some excellent reference information. The list of AWWA standards, unfortunately, is somewhat out of date.

The Future of Cities and Urban Redevelopment. *Coleman Woodbury, ed. University of Chicago Press, 5750 Ellis Ave., Chicago 37, Ill. (1953) 764 pp.; $9*

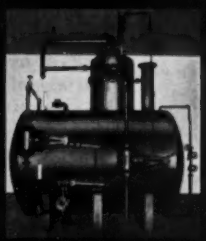
There is a type of man who, not contented with his daily rounds, must know why he does them, whether there is a better way, whether they are even worth doing at all. The water works man who embarks on this quest may occupy himself more or less harmlessly with inquiring into the biological and technological reasons that make a supply of water necessary, and the significance of the impurities that can accompany it. He will find an answer—or he will not—but his antics will only amuse and not alarm his associates.

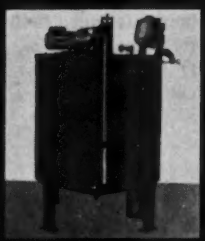
Should he question the social structure that has called his function into being, however—the city itself, its shape, its population, its quality—he has embarked upon a shoreless and bottomless sea, and his dearest friends will give him up for lost. Yet, although there is no end to the search, there are certain rewards for the seeker—if only in learning that the integration of plans for change or ex-

(Continued on page 48 P&R)

what's the cost in the long run?

There's no dodging the question today. High costs and low budgets demand straight answers. The installation of water conditioning equipment is an important step that merits the careful consideration of every factor involved. Modern General Filter water conditioning installations are designed with a practical eye on original equipment and installation costs. Equally important, however, is the extent of continuing service available from the company with which you are dealing. General Filter's staff of highly trained engineers and chemists are at your call on a moment's notice. General Filter's 40 branches are located across the country to give you prompt dependable service. Make your own comparisons and you will join the hundreds of General Filter water treatment plants that are enjoying lower first cost lower operating costs lower maintenance costs.





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(Continued from page 46 P&R)

pansion with other elements in the community is a practical necessity, and not a political accommodation. But it goes deeper and further than that, and exposure to the uncluttered vision of the dozen authors of this book may persuade a few select readers to question why their cities do not represent straightforward and efficient mechanisms for social living, and to wonder what can be done about it. The goal is a community in which it is comfortable, esthetically satisfying, pleasant, and economical to live. It may never be reached, but that's all the more reason for trying.

More Water for Texas: *The problem and the plan. Walter Prescott Webb. University of Texas Press, Austin 12, Tex. (1954) 69 pp.; $2.75*

With the problem we are all too familiar (see also *Water Supply and the Texas Economy*, December 1953 JOURNAL, p. *48 P&R*). The solution, advanced by the Bureau of Reclamation and explained by Mr. Webb, a historian, is a $1,100,000,000 complex of storage reservoirs, irrigation systems, and canal works. The canal would be constructed about 60 or 70 miles from the coast and parallel with it, intercepting the rivers and diverting the surplus flows in the north to the arid regions in the south. Lift pumps at 20-mile intervals would keep the water moving. The plan contemplates relief only for the southern coastal area; inland and western Texas are beyond its scope.

Elementary Fluid Mechanics. *John K. Vennard. John Wiley & Sons, New York (3rd ed., 1954) 401 pp.; $5.50*

The word "elementary" is always applied relatively, and there are few subjects to which the term is customarily applied that are as complex as fluid mechanics. Prof. Vennard, who teaches the subject at Stanford University, is as good as his word will permit him to be, however, starting with fundamentals and very shortly leaving us far behind, admiring the laminar and turbulent flow of his thought, and its occasional hydraulic jumps. Not to be too facetious about a serious work, we should add that it is designed as a text for the third-year engineering student. End-of-chapter problems make things easy for the instructor and prove to the student that a complaisant understanding of Prof. Vennard's general drift will not suffice.

Laboratory Instruments: *Their design and application. A. Elliott & J. Home Dickson. Chemical Pub. Co., Inc., 212—5th Ave., New York 10, N.Y. (1953) 414 pp.; $7.50*

This book is concerned with the principles of construction of such apparatus as the laboratory worker might have to construct for himself. Chapters on the characteristics of various materials, attainable accuracy in dimensions, metal casting and working, glass cutting and polishing, together with much material on lenses and various types of optical and photographic instrument elements, are included.

Chemical Character of Surface Water in Pennsylvania, 1949–1951. *Norman H. Beamer. Pub. 26, Pennsylvania Dept. of Commerce, State Planning Board, Rm. 129 Capitol Bldg., Harrisburg, Pa. (1953) 96 pp.; paperbound; free from State Planning Board or US Geological Survey, Rm. 1302 Custom House, 2nd & Chestnut Sts., Philadelphia 6, Pa.*

This report on the chemical characteristics of Pennsylvania's surface waters is the result of a cooperative program of the US Geological Survey and the Pennsylvania Dept. of Forests & Waters. It is a sequel to Pub. 17 and Pub. 23, which covered the 1944–1949 period.

(Continued on page 50 P&R)

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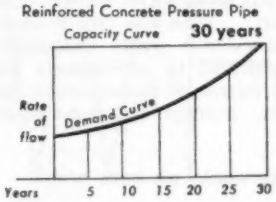

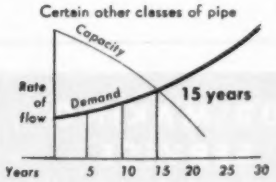

TREMENDOUS GROWTH AND POPULATION GAINS have made many community planners and water works engineers realize that in order to satisfy future needs, their main water supply lines *must* have a high sustained hydraulic capacity.

An interesting example of foresight and long range planning is the program for enlarging the water system of the City of Burbank, California. Fully realizing that the post war years would bring unprecedented population gains to their area, the City Manager, the Planning Commission and the Engineers in the Public Service Department of the City of Burbank planned and installed additional permanent water mains in anticipation of future demands. These installations involved considerable footage of American Concrete Cylinder Pipe in sizes 16″ through 36″. The City of Burbank's water system totals approximately 230 miles and has reached multi-million dollar proportions.

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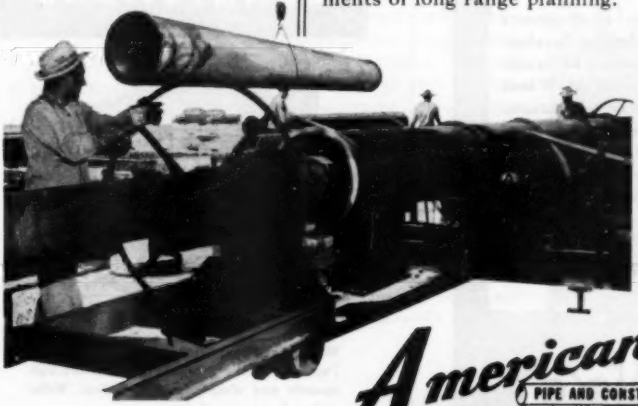

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The Reading Meter

(*Continued from page 48 P&R*)

Sewage Service Charges in Cities Over 5,000 Population. *Public Works Engineers' Special Report No. 18, American Public Works Assn., 1313 E. 60th St., Chicago 37, Ill. (1953) $2*

A compilation of the charges for sewage service in all but the smallest cities.

The Natural History of Infectious Disease. *Macfarlane Burnet. Cambridge Univ. Press, Cambridge (2nd ed., 1953) 356 pp.; $4.50 from Cambridge Univ. Press, 32 E. 57th St., New York 22, N.Y.*

One entertaining sidelight of this excellently written study of the evolution of disease and the biological mechanisms involved is the suggestion the author half-seriously advances that the entire process of water and sewage treatment has arisen through ignorance. Before the bacterial nature of typhoid fever was understood, the relation to unsanitary conditions was recognized clearly enough, and the water and sewage works are the results. When the disease was understood sufficiently, prevention by inoculation became possible:

This worked extraordinarily well during both wars, and cynics have suggested that perhaps it was just as well that vaccination of this sort was unknown in the mid-nineteenth century. Otherwise the cheaper method of inoculation would undoubtedly have been preferred by governments and municipalities instead of the expensive, but more effective, drainage and water-supply schemes.

And where would we have been?

(*Continued on page 52 P&R*)

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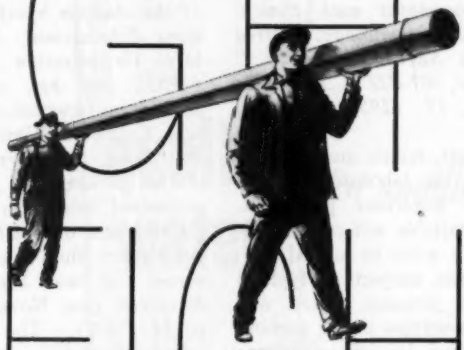

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The Reading Meter

(Continued from page 50 P&R)

Salmonellae and Shigellae: *Laboratory diagnosis correlated with clinical manifestations and epidemiology. Alfred J. Weil & Ivan Saphra. Charles C Thomas, Publisher, 301–327 E. Lawrence Ave., Springfield, Ill. (1953) 247 pp.; $7.75*

Photomicrographs, tables, and color illustrations aid in the laboratory identification of some notorious pathogens. Some of the comfortable self-congratulation which we are wont to accord ourselves whenever the subject of typhoid fever and related diseases arises was dissipated by the assertion of the authors that there are glaring deficiencies in case reporting. For example, they observe that of 23,315 cases of bacillary dysentery reported in the US in 1950, 19,196 came from Texas. "It needs, we hope," they continue, "no assurance that Texas is not the national palyground for shigellae. It is just doing some commendably effective case finding. . . ."

One reaction of a lay reader is that some stylistic consistency in the use of italics, capitals, and an avoidance of improper plural forms for bacteriologic nomenclature would have been well employed.

Municipal Service to Fringe Area Residents: *A survey of Tennessee practices. Pub. 253, Tennessee State Planning Commission, 517 Commerce St., Nashville 3, Tenn. (1593) 37 pp.; paperbound; $1*

This bulletin provides a survey, with appropriate commentary, of the services which Tennessee municipalities extend to their suburbs and what charges they make for them. Fire protection, water supply, sewerage, and garbage collection are the utilities covered. The text discusses how municipal policies on these matters may affect the quality of services within the community, the relationship to annexation possibilities, and the general philosophy of providing tax-supported services to nontaxpayers.

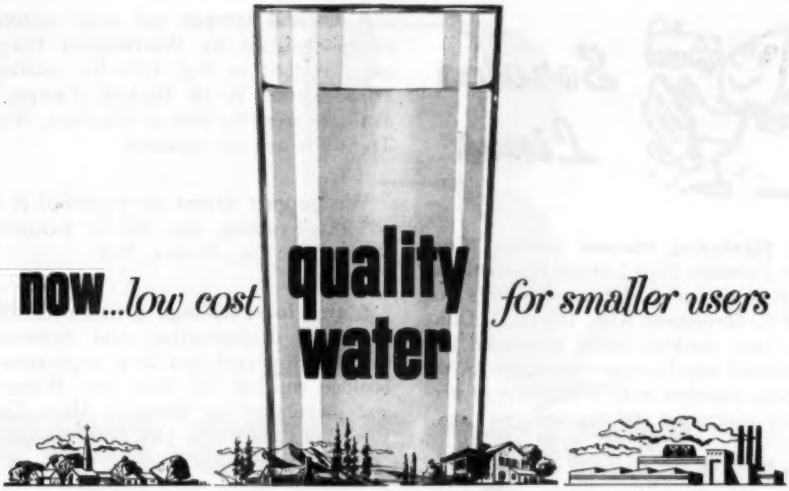
Arid Zone Hydrology: *2. Proceedings of the Ankara Symposium. United Nations Educational, Scientific, and Cultural Organization (UNESCO), Paris (1953) 268 pp., charts; paperbound; $5.50 from International Documents Service, Columbia University Press, 2960 Broadway, New York 27, N.Y.*

The proceedings of this conference, organized jointly in April 1952 by the government of Turkey and UNESCO, constitutes the second volume in the series that was begun by *Reviews of Research* (see November 1953 Journal, p. *54 P&R*). The discussions in this volume center on the ground water situation in arid regions and its potentialities for meeting the unusual needs of these areas. Geophysical prospecting is discussed by several contributors; others consider such matters as the effect of ground water draft upon the hydrological balance. The more theoretical considerations involved in the ecology of arid regions, such as the relationship of ground water to human geography and ways of life, or to geologic processes, are also considered.

A forthcoming title in this series that should be of interest will be No. 4—Reviews of Research on Problems of Utilization of Saline Water.

Federal Excise Taxes: *Exemptions allowed local and state governments. Special Bul. 1954B, Municipal Finance Assn. of the US and Canada, 1313 E. 60th St., Chicago 37, Ill. (1954) 4 pp.; paperbound; 50¢*

Contains a list of the new manufacturers' and retailers' excise taxes, together with instructions for obtaining exemptions. The procedure for obtaining exemptions on telephone and telegraph service, and transportation of persons or property, is also given. Qualified local governments may recover erroneous payments of federal excise taxes by filing for a refund. For some taxes they have up to four years in which to file.



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A pipelaying manual entitled "Concrete Pressure Pipe Laying Instructions" has been prepared by Price Brothers Co., 1932 E. Monument Ave., Dayton 1, Ohio. The 16-p. booklet offers a detailed and illustrated step-by-step explanation of the process, together with a checklist of necessary equipment and supplies.

"It Could Happen to You," a 14-p. booklet on the value of a public water supply system for communities which lack it, is being distributed by the Cast Iron Pipe Research Assn., 122 S. Michigan Ave., Chicago 3, Ill.

Air-operated butterfly valves and Air-O-Motor Operators are described in two booklets, Bul. 1701 and 414–1, available from Minneapolis-Honeywell Regulator Co., Station 213, Wayne & Windrim Aves., Philadelphia 44, Pa.

Automatic pump sequence control systems produced by Fischer & Porter Co., 48 Jacksonville Rd., Hatboro, Pa., are described in Catalog 91–106, available on request. The system makes use of kinetic manometry to actuate a float, in turn inducing an electrical change through an armature. The voltage thus induced is used to trigger the pump controls. Also available is Catalog 10–F–70, describing a self-operated flow regulator, which utilizes the energy of flowing liquids to maintain the flow at constant level.

"Instrumentation" magazine's index for 1943–1953 is obtainable on request from Minneapolis-Honeywell Regulator Co., Station 213, Wayne & Windrim Aves., Philadelphia 44, Pa.

A backfill tamper and gang tamper newly designed by Worthington Corp. are described in Bul. 1224–B1, entitled "Blue Brute W–18 Backfill Tamper," available from the firm at Harrison, N.J. The units are air operated.

Wedge gate valves are described in a condensed catalog, Bul. 107, of Kennedy Valve Mfg. Co., Elmira, N.Y.

Major ion-exchange procedures for softening, dealkalization, and deionization are discussed in a 24-p. explanatory booklet entitled "If You Use Water," and distributed by Rohm & Haas Co., Resinous Products Div., Washington Sq., Philadelphia 5, Pa.

Pipelaying projects of C. N. Flagg & Co., Meriden, Conn., are described and illustrated in a 45th anniversary bulletin entitled "Pipeline Progress."

Bauxite and other aluminum chemicals are the subject of a data folder issued by Reynolds Chemicals, 2500 S. 3rd St., Louisville, Ky.

Diatomite filters for swimming pools and other applications are described and their operation explained in a folder available from Graver Water Conditioning Co., 216 West 14th St., New York 11, N.Y.

Welding elbow strains are the subject of a paper entitled "In-Plane Bending Properties of Welding Elbows," reprints of which may be obtained as Bul. 534 from Taylor Forge & Pipe Works, Box 485, Chicago 90, Ill.

Butterfly and other valves of W. S. Rockwell Co., 200 Eliot St., Fairfield, Conn., are described in a series of catalog bulletins on the manually or automatically controlled types. Complete specifications are given and various types of actuators offered.

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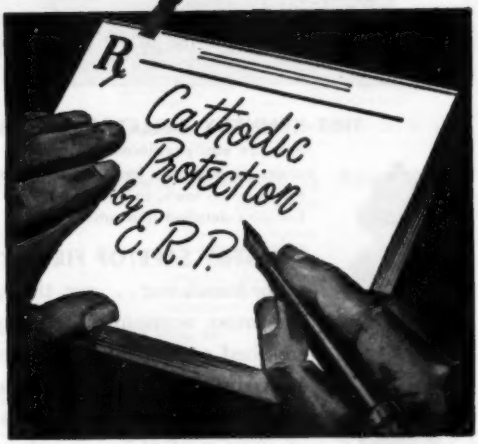

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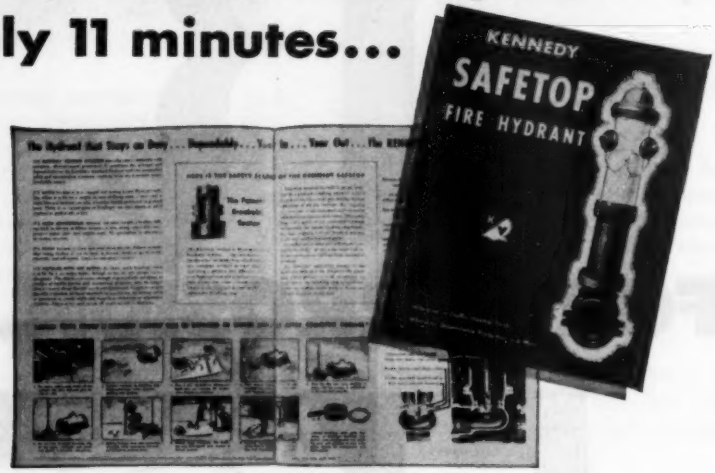

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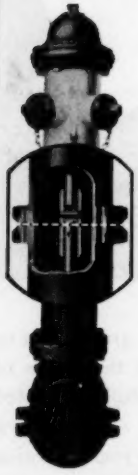

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Key: In the reference to the publication in which the abstracted article appears, **39**:473 (May '47) indicates volume 39, page 473, issue dated May 1947. If the publication is paged by the issue, **39**:5:1 (May '47) indicates volume 39, number 5, page 1, issue dated May 1947. Abbreviations following an abstract indicate that it was taken, by permission, from one of the following periodicals: *BH—Bulletin of Hygiene (Great Britain); CA—Chemical Abstracts; Corr.—Corrosion; IM—Institute of Metals (Great Britain); PHEA—Public Health Engineering Abstracts; SIW—Sewage and Industrial Wastes; WPA—Water Pollution Abstracts (Great Britain).*

HEALTH, HYGIENE, AND FLUORIDATION

Test of Chronic Toxicity of Iodine as Related to the Purification of Water. D. P. MORGAN & R. J. KARPEN. US Armed Forces Med. J., **4**:725 ('53). NaI was introduced into chlorinated drinking water in tropics so that avg daily dose of I/man was 12 mg for 16 wk and 19.2 mg for next 10 wk. This is larger dose of I than would be required for sterilization of drinking water through use of I-liberating compds. such as tetraglycine periodide. No adverse results were noted in personnel consuming I-contg. H_2O.—*CA*

Avoiding Lead Poisoning From Newly Installed Lead Pipe. G. GAD & K. NAUMANN. Gesundh.-Ing., **74**:85 ('53). Treatment of Pb pipe with soln. contg. 30 ml of Na silicate (40°–42° Bé.)/l for 48 hr formed protective layer that prevented soln. of Pb when distd. H_2O satd. with CO_2 was passed through pipe. Na_3PO_4 (3%) gave no protective layer. Na_2HPO_4 (3%) and mixt. of Na silicate (3%) and Na_2HPO_4 (3%) gave some protection, but were not as effective as Na silicate alone.—*CA*

Hygienic Determination of Tolerable Concentration of Lead in Water Storage Reservoirs. A. F. ZAITSEVA. Gigiena i Sanit., No. 3, p. 7 ('53). Concn. of Pb of 0.1 mg/l appears to be limit beyond which it may affect sanitary regime of reservoir in respect to its self-purification by biol. means. Taste qualities are not affected by even very much larger concns. Chronic changes in central nervous system of white rats were observed after intake of 0.005 mg of Pb/kg. Drinking-water tolerance is suggested at 0.1 mg/l. —*CA*

Nitrates in Manitoba Water Supplies. L. A. KAY, W. M. WARD & I. D. HENDIN. Can. J. Pub. Health, **44**:3:95 ('53). Study of nitrates in water supplies in connection with methemoglobinemia in infants was begun in Manitoba in '49. Examination of 300 rural well waters showed that 33% contained over 10 ppm of nitrate and were therefore potentially dangerous for artificially fed infants. No direct correlation between fecal contamination (judged by *Esch. coli* test) and nitrate content was found. Methods for detn. of nitrates in field and laboratory testing were considered. In '50 study was extended. Experiments on removal of nitrate from water by resins are recorded, and good results were obtained by system of dual ionic exchange. Better results followed use of mixed cation- and anion-exchange materials, but this system has disadvantage that no effective joint regeneration of mixed-resin bed was evolved. Preliminary investigations are in progress to study soils, rainfall, general sanitary conditions, artificial fertilization of arable land, and other chemical constituents in relation to high nitrate content. Top-priority service to physicians and local health authorities has been set up to provide quantitative analysis of suspected high-nitrate waters.—*BH*

Asphyxiation in Street Manholes. G. S. MICHAELSEN & W. E. PARK. Pub. Health Rpts., **69**:29 ('54). Death of plumbing employee in manhole that had repeatedly been entered without ill effect stimulated investigation. Found that rising barometric pressure had some effect by reducing air diffusion through cover, but prime source of trouble appeared to be oxygen demand by organic materials in surrounding soil. In absence of such chemical oxygen demand, test manhole, completely filled with nitrogen and sealed, found to have regained normal oxygen content in 24 hr by diffusion from surrounding soil. Concluded that oxygen depletion

(*Continued on page 64*)

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(*Continued from page 62*)

in manholes is potential danger, particularly in low or swampy areas, where substances in subsoil, other than vegetable matter, may increase oxygen demand. Air flow through manhole covers ineffective in maintaining equilibrium with air outside, although there is free and rapid diffusion of gases through manhole walls and floor.—*Ed.*

Newburgh-Kingston Caries-Fluorine Study. V. Pediatrics Aspects—Continuation Report. E. B. SCHLESINGER, D. E. OVERTON & H. C. CHASE. Am. J. Pub. Health, **43**:1011 ('53). Findings on pediatric examns. of children studied in Newburgh and Kingston over period of 6 yr since introduction of fluoride in Newburgh water supply are reported. Phys. examns., including measurements of height and wt., selected lab. tests, and Röntgen studies fail to disclose any significant deviations in any factors studied in group of children ingesting fluoridated water as compared with control group. Although pediatric aspects of Newburgh-Kingston study will be continued for full 10 yr of total study to obtain data originally sought, there is no reason to anticipate any systemic effects from fluoridated drinking water.—*CA*

On the Question of the Fluoridation of Drinking Water. H. KRUSE. Gas- u. Wasserfach, **94**:511 ('53). Review of work leading to discovery of cause of fluorosis and subsequent research in US defining optimum fluoride concns. in drinking water. In discussing other possible fluoride vehicles (tablets, milk, salt, bread, and other foods) author concludes that water supplies are at present most reliable and practical method. Most European supplies contain less than 0.15 ppm fluoride, with only mineral waters having more than 0.5 ppm. At present Federal Health Service at Berlin-Dahlem is testing for fluoride all German water supplies. Fluoridation costs at Kassel avg 7¢/cap./yr. Author recommends supplementation of all fluoride-deficient supplies in

(*Continued on page 66*)

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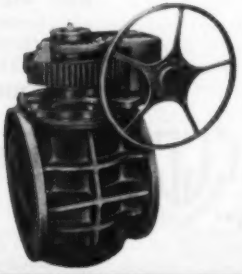

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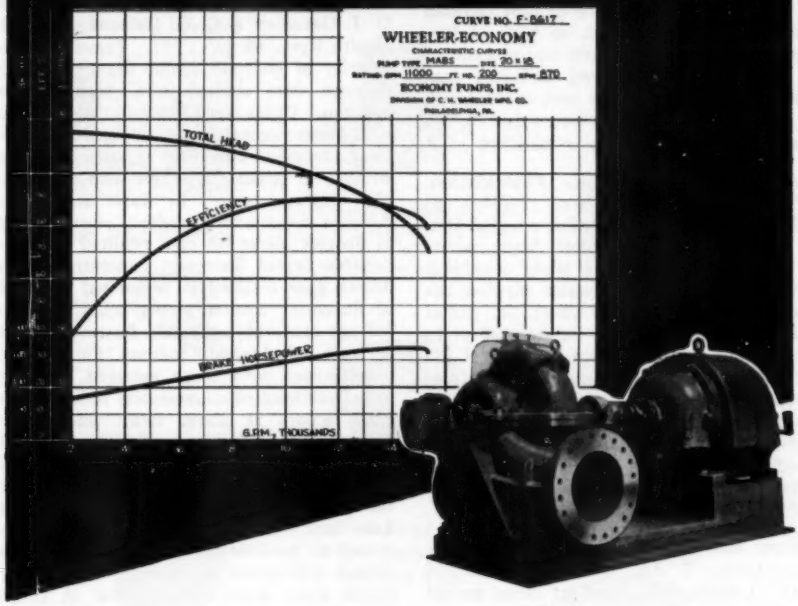

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(*Continued from page 64*)

Germany; not by itself as panacea against caries, but in conjunction with proper nourishment and dental care.—*F. J. Maier*

Fluoridation of Drinking Water at Kassel. H. HUGELMANN. Gas- u. Wasserfach, **94**: 507 ('53). Kassel was one of first German cities to adopt fluoridation on basis of foreign experiences. Equipment and procedures for doing this are outlined, and cost data given. No difficulties have been encountered, but it will be 10–15 yr before value of this program can be definitely established.—*CA*

Further Resolution on Fluoridation. W.W. Inf. Exch.—Can. Sec., AWWA, **8**: A:2:4 (Dec. '53). Resolution, adopted Oct. 17, '53, by Canadian Dental Assn., points out that 8 yr of extensive study of adding about 1 ppm F to public water supplies has revealed same beneficial effect on dental health as has been known for over 20 yr to accrue from consuming water contg. F acquired naturally, and with same freedom from systemic ill effects. Resolution recommends that communities with public water supply adopt procedure for water fluoridation best suited to local needs, based on competent dental, medical, and engineering advice.—*R. E. Thompson*

Climate and Controlled Fluoridation. D. J. GALAGAN. J. Am. Dental Assn., **47**:159 ('53). Climate (measured by mean annual temp.) is influential factor in H_2O consumption of infants and children; those born and raised in areas with mean annual temp. of 70°F consume approx. twice as much H_2O as those in areas with temp. of 50°F. In treatment of water supplies, fluoride concn. should be adjusted to climatic conditions; 1–1.2 ppm fluoride may be considered optimum in zones comparable to Great Lakes area, 0.6 ppm equally effective in areas similar to southern Arizona.—*CA*

Climate and Endemic Dental Fluorosis. D. J. GALAGAN & G. G. LAMSON JR. Pub. Health Rpts., **68**:497 ('53). Prevalence and severity of endemic dental fluorosis in 726 children were studied in 6 Arizona communities. Cities were located in desert area, with mean annual temp. of approx. 70°F, mean relative humidity of approx. 37%, 80–85% of possible sunshine, and extremely high daytime temp. In water supplies of Arizona communities studied, concentrations of fluoride above 0.8 ppm resulted in objectionable dental fluorosis; concentrations of 0.6–0.8 ppm resulted in occasional diagnosis of fluorosis; concentrations below 0.6 ppm did not cause objectionable fluorosis. Comparisons of fluorosis indexes for Arizona communities with those obtained from selected midwestern communities indicate fluorosis occurs at about twice intensity in that section of Arizona as it does in midwestern area with comparable fluoride concentrations but markedly different climatic factors. Variations in temp., radiant heat gain, and relative humidity have been discussed as possible influential factors in observed differences in endemic fluorosis between these areas. Application of simple biological test in these areas suggests that, because of several climatological influences, Arizona children drink more water than children living in more temperate climate. As result, there is increased ingestion of fluoride in relation to concentration found in water supply.—*PHEA*

(*Continued on page 68*)

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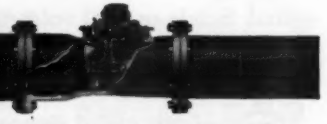

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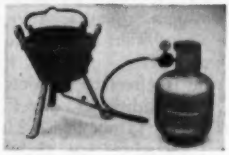

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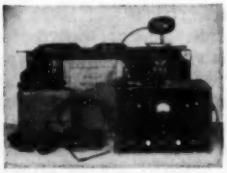

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(*Continued from page 66*)

Fluoride in the Drinking Water of Two Villages in Nagano Prefecture and Its Relation to the Occurrence of Mottled Enamel. I. HORASAWA, K. HAGIWARA & F. NAKAJIMA. Bul. Inst. Pub. Health (Japan), 2:3:24 (Dec. '52). People in villages of Tokiwa and Matsukawa take their water without prior treatment from brooklets running from Takase R. after water has been used in electric generators. River originates in hot springs in Japanese Alps and carries 0.35–0.8 ppm fluorides. Children in elementary and junior high school classes were checked for fluorosis as indicated by tooth mottling. In Tokiwa, 43% of 384 junior high school and 41% of 754 elementary school children showed mottling, while, in Matsukawa, rates were 58% of 343 and 50% of 762 children. Authors felt that waters of these brooklets should be diluted with waters from relatively fluorine-free sources in area.—*PHEA*

Chronic Endemic Dental Fluorosis in Kenya, East Africa. T. OCKERSE. Brit. Dental J., 95:3:57 ('53). It was known that children with mottled enamel were numerous in some parts of Kenya, and author was therefore asked by director of medical services to make report on occurrence of dental fluorosis in certain areas. He carried out investigation in Jul. '52, places visited being in or near Rift Valley area, where water supplies were known to contain excessive amounts of fluorine. Of 712 Asian children examined, mottled enamel was found in 67%, and of 592 African children, mottling was present in 47%. Among European children examined, there were 112 with mottled enamel, but author does not express this as percentage of total number examined. Among Asian children, mottling was more prevalent and more severe in vegetarians than in meat eaters, and author considers it possible that lack of first-class protein, with high carbohydrate intake, increases susceptibility. At Nairobi, fluorine content of water supply is 0.5 ppm but author found that, at Eastleigh, Nairobi, majority of children had mottled teeth. This may be because town supply was supplemented by water from 6 boreholes during shortage in '45 and '46. There are good reasons for believing that this supply from boreholes contained much more than 0.5 ppm fluorine. No case of chronic systemic fluorine poisoning has so far been reported, and none was seen by author.—*BH*

Fluorides in Water Supplies. R. C. HOATHER. J. Roy. San. Inst., 73:202 ('53). Author discusses in some detail distribution of fluorine in surface and underground water supplies. Fluorine is absent (or less than 0.1 ppm) in most surface supplies and in many underground supplies. In others, usually those with small yield, fluorine may be present up to about 5 ppm. Author reviews some of literature on relation of fluorine to fluorosis and dental caries. Author feels that 0.7 ppm fluorine is effective in controlling caries and that additional effect of higher concentrations up to about 1.5–2.0 is relatively small. Concludes that there is strong evidence that addition of suitable amount of fluorine to public water supplies in Britain which do not already contain it would have effect of very greatly reducing incidence of dental caries.—*PHEA*

Effect on Teeth of Intermittent Fluoridation of a Community Water Supply. H. W. BRUCE JR. & B. G. GUNTER. J. Dental Research, 32:35 ('53). Lower caries incidence and higher prevalence of mottled enamel were noted in children whose water supply was derived from creeks flowing at varying rates of speed over phosphate rock rich in F. Beneficial effect on teeth of this fluoridation occurred when F concn. was in range 0.2–1.0 ppm.—*CA*

A Survey of the Fluoride Content of Israel Domestic Water Supplies. I. GDALIA. J. Med. Assn. Israel, 44:10:1 (May 15, '53). Survey was undertaken to gather data on natural-fluoride content of Israel domestic water supplies. 71 sources of water supplies from wells, springs, rivers, and lakes were examined. Fluoride content varied from 0.30 to 1.50 ppm on avg. Taking into account large amounts of water drunk in warm season, concentration of 0.5–0.7 ppm fluoride seems to be sufficient for caries inhibition. Further investigations on fluoride-caries relationship among children are in progress. —*Ed.*

Water Fluoridation and Impurity Coagulation. W. E. WHITE. U.S. 2,643,226 (June 23, '53). Water is fluoridated by addn. of water-sol. salt whose assumed compn. is $AlFSO_4$. Presence of Al in soln. aids coagulation upon addn. of alkali and maintains fluoride ion concn. below 2.5 ppm.

(*Continued on page 70*)

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(*Continued from page 68*)

CaF (1 lb), 7.7 lb of alum, and 30 lb of water are mixed and heated at 80°–90° for 4 hr. Solids are sepd., and soln. is evapd. to yield about 6 lb of $AlFSO_4$.—*CA*

CANADIAN WATER SUPPLIES —GENERAL

Increase in Water Works and Sewerage Systems in Alberta. W. A. DEXTER. Munic. Util. (Can.), 91:7:25 (Jul. '53). Communities with water and sewerage systems increased from 38 to 95 since war, chiefly due to Self-Liquidating Projects Act ('50), whereby municipalities have been able to borrow for such projects from provincial government at 2% interest, with principal repayable in 20 yr entirely from service charges and frontage tax. Certificate of approval from provincial board of health required. Provisional certificates, based on preliminary reports and ests., permit municipality to seek assent of taxpayers before detailed design made. In '50, stream sanitation section of division of sanitary engineering established, with well-equipped, permanent lab. and mobile lab. for field work.—*R. E. Thompson*

Rapid Sand Filtration at Lethbridge [Alta.]. J. C. NEUFELD. Munic. Util. (Can.), 90:10:22 (Oct. '52). Practice in design and operation of filter plants reviewed and some details of Lethbridge plant included. Supply to latter from Oldman R., which has tributary drainage area on eastern slopes of Rocky Mts. Turbidity ranges from 50 to 3,000 ppm, and pH from 7.4 to 8.5. Plant consists of 8 filters, 14.5′ × 20.83′, with total area 2,420 sq ft, providing 6.9-mgd capac. at 2 gpm/sq ft. Addn. of presedimentation and coagulation basins and improved pretreatment expected to increase capac. to 8.5 mgd. Combined air-water wash, air being applied 3–5 min before backwashing. Wash water used: 7–11 gal/sq ft/min. Sand expansion can be detd. by lowering waterproof elec. light attached to calibrated rod into filter during washing and

(*Continued on page 72*)

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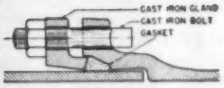

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(Continued from page 70)

observing depth at which light obscured.—*R. E. Thompson*

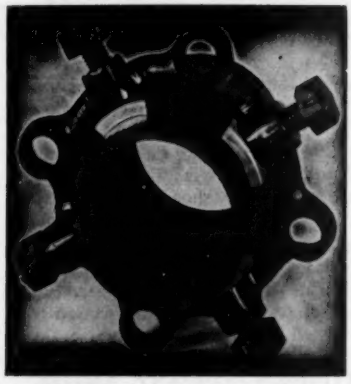
First Stage of Water Works Improvement Program Completed in Fredericton [N.B.]. ANON. Munic. Util. (Can.), 91:8: 21 ('53). St. John R., used since 1883, purified by filtn. and chln. for many yr. Present capac. 1.6 mgd. Estd. pop. 25,000 in '75. On basis of 100-gpcd consumption, although present use 65–70 gpcd, capac. should be 2.5 mgd. Of improvements recommended, 2-mil gal reservoir and 2 mi of 18" and 12" supply mains completed at cost in excess of $240,000. Reservoir, about 1 mi from river, top water el 190, provides near-normal pressure in event of pump stoppage. Structure is of reinforced concrete with flat-slab roof and 30" earth cover and consists of 2 independent basins 80′ × 125′ × 16′, with separate inlets. Cost $105,000. Excavation largely in rock. Leakage on completion due to cracks in floor caused by settlement of gravel base over rock. Corrected by 3-ply waterproof membrane of asphalt and woven glass. Other improvements recommended include new 24" intake to deliver 4 mgd at min. river el, new low- and high-lift pumps, and filter plant extensions to provide total capac. of 2.5 mgd, with 40-min mixing period and 200-min settling. Before proceeding with these projects, test wells being drilled to investigate possibility of supplementary ground water supply.—*R. E. Thompson*

Sanitary Engineering in Ontario. A. E. BERRY. Munic. Util. (Can.), 91:3:20 (Mar. '53). Activities of San. Eng. Div. of Ontario Dept. of Health, established in '13, cover all aspects of environmental sanitation, including lab. and research facilities. Plans and specifications for water and sewerage works must be submitted for approval. Mandatory orders may be issued. There are now 395 water works systems, surface water being used in 223 and ground water in 183 (11 use both); filter plants number 76. Fluoridation practiced in 5 municipalities. There are 269 sewer systems and 139 treatment plants.—*R. E. Thompson*

First Phase of Montreal [Que.] Water Works Expansion Approved by Council. J. KOENIG. Eng. Cont. Rec. (Can.), 65: 9:98 (Sep. '52). Three-stage program will increase present supply of 200 mgd by 50%. Estd. cost of 12 items comprising first phase $13,000,000. Included are new mains and appurtenances; new reservoirs; improvements to intakes, aqueduct, and pumping stations; and new feeder mains. Second stage being planned, and meanwhile fifth 50-mgd filter gallery at Verdun plant will be authorized. Other items of second stage include 100-mil gal reservoir, purchase of land for 2 other reservoirs, feeder mains, and lining of steel mains with cement. Cost will approach that of first stage. Final stage will include another 100-mil gal reservoir with provision to increase to 200 mil gal; sixth filter gallery at Verdun and modernization of first 3 galleries; feeder mains; reservoir extensions; and restoration of aqueduct canal.—*R. E. Thompson*

Water and Sewerage Works in Quebec. T. J. LAFRENIERE. Munic. Util. (Can.), 91:3:21 (Mar. '53). Plans for water supply and sewerage, with specifications and

(Continued on page 74)



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(*Continued from page 72*)

est. of cost, must be submitted for approval to San. Eng. Div. of Quebec Ministry of Health, established in '09. Minister of health can order remedial measures to improve quality of water supplies or to reduce stream poln. Adjoining municipalities may be compelled to have works in common. Control is exercised by inspection and lab. examns. Operators may be suspended, dismissed, or replaced by minister. There are approx. 700 water works in province, 75 filter plants, and 130 chlorination installations.—*R. E. Thompson*

Control of Water and Sewage Works in Saskatchewan. J. G. SCHAEFFER. Munic. Util. (Can.), **91**:6:26 (Jun. '53). Minister's approval must be obtained before water or sewerage system constructed, altered, or extended. Sanitary engineering division stipulates degree and kind of treatment. Minister may order installations or improvements. Control of existing works by inspection and sampling. Division personnel available for consultation; also make preliminary investigations, for municipalities, of proposed works—including field survey, initial general design, and cost est. There are 44 municipal water works. Surface water limited; most smaller communities and some larger ones use ground water. Domestic water softeners numerous.—*R. E. Thompson*

Modern Water and Sewage Works for Group of Newfoundland Towns. A. C. NORTHOVER. Munic. Util. (Can.), **91**:6:23 (Jun. '53). Water and sewerage systems of Corner Brook, Corner Brook West, Corner Brook East, and Curling amalgamated recently under Water and Sewerage Corporation of Greater Corner Brook. Estd. cost of water supply plans $1,860,000. Rock crib, clay core dam will raise elevation of existing lake 15′ and create 30-acre reservoir to supply Curling West—yield estd. at 270 gpm, sufficient for 4,500 people. Intake and 12″ supply line, 1.5 mi. long, will be of cast iron. Regulating-valve stations required in latter, as reservoir elevation is 550′ and parts of area served are only 50′ above sea level. Corner Brook West, pop. 7,500, on side of mountain, el 0–500′. Supply for town and Corner Brook East (5,500 pop.) from reservoir formed by existing dam at el 690′. 18″ supply main, 7,400′ from reservoir, will divide into 16″ and 14″ mains to towns, 12,900′ and 9,000′ long, respectively. Mains will be of asbestos cement, cast iron, and steel. Elevation of route for 16″ main varies from 125′ to 500′, necessitating vacuum breakers where main above hydraulic gradient. Pressure-regulating stations to reduce initial 180–200-psi pressure required in both towns. Min. pressure in residential areas 40–45 psi, max. in high-pressure residential areas 110 psi. Above el 300′, Corner Brook West will be served by elec. station (gasoline engine standby) and 207,000-gal preload tank at el 500′. Avg domestic consumption estd. at 80 gpcd.—*R. E. Thompson*

OTHER ARTICLES NOTED

Recent articles of interest, not abstracted, are listed below.

New Type Water Intake Proves Success. A. R. TODD. Pub. Wks., p. 81 (Feb. '54).

Harvesting Underwater Weeds. D. F. LIVERMORE. W.W.Eng., **107**:118 (Feb. '54).

System Head Curves—Their Calculation and Use. MELVIN MANN. Wtr. & Sew. Wks., **101**:14 (Jan. '54).

Water Analyses Aid in Selection of Plumbing Materials. V. F. NOLE. Pub. Wks., p. 66 (Feb. '54).

Deterioration of Cooling-Tower Lumber. ANON. Betz Indicator, **23**:1:3 (Jan. '54).

New Type River Intake. A. R. TODD. Wtr. & Sew. Wks., **101**:108 (Mar. '54).

A Well Shoots the Works. M. P. SCHNELLER, J. B. MILLIS & J. T. BROWNING. Am. City, **69**:3:116 (Mar. '54).

Dry Ice Successfully Used, Freezes Twelve-Inch Pipe. W. S. MAUS. W.W.Eng., **107**: 213 (Mar. '54).

Broader View Is Needed by River Developers. C. J. VELZ. Eng. News-Rec., **152**: 12:39 (Mar. 25, '54).

Water Supply Systems of the Philippine Islands. E. C. MACALALAG. W.W.Eng., **107**:219 (Mar. '54).

Airdrome Is Water Supply Reservoir. M. D. MORRIS. Pub. Wks., **85**:3:85 (Mar. '54).

Homemade Jar Test Agitator Used in Florida Laboratory. ANON. W.W.Eng., **107**: 303 (Apr. '54).

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CHANGES IN MEMBERSHIP

NEW MEMBERS

Applications received Apr. 1–30, 1954

Abbey, Robert J., Mgr., Lewiston Orchards Irrigation Dist., 1520 Powers Ave., Lewiston, Idaho (Apr. '54) *MPD*

Ager, E. L., Pump Dept. Mgr., Thorpe Well Co., 2340—6th Ave., Des Moines, Iowa (Apr. '54) *R*

Alabama League of Municipalities, E. E. Reid, Exec. Director, 24 S. Hull St., Box 1270, Montgomery, Ala. (Munic. Sv. Sub. Apr. '54)

Alexander, M. H., Water Works Mgr., Box 1117, Hobbs, N.M. (Apr. '54) *MD*

Allenbaugh, Edward N.; *see* Ellensburg (Wash.) Water Dept.

Archibald, Harry P., Cons. Engr., Bayfield & Archibald, 448 Seymour St., Vancouver 2, B.C. (Apr. '54) *D*

Armstrong, C. Maurice, Civ. Engr., C. G. Russell Armstrong, 605–6 Bartlet Bldg., Windsor, Ont. (Apr. '54)

Atkinson, Leslie S., Supt. Parochial Roads & Works, Parochial Board, Trelawny, Falmouth, Jamaica, B.W.I. (Apr. '54)

Ayala H., Juan Pablo, Calle Traversera de Gracis No. 10, Barcelona, Spain (Apr. '54)

Baker, Robert J., Chemist, Wallace & Tiernan, 25 Main St., Belleville, N.J. (Apr. '54) *PD*

Baskous, A. A., Sr. San. Engr., State Dept. of Health, Albany, N.Y. (Apr. '54) *MRPD*

Beach, Frank W., Engr., Cities Service Oil Co., Bartlesville, Okla. (Apr. '54) *MRPD*

Biele, Arthur V., Bacteriologist, Water, Gas, Sewage Treatment Dept., Duluth, Minn. (Apr. '54) *P*

Brannon, Leo Jay, Supt., Water Dept., Bentonville, Ark. (Apr. '54) *MP*

Brignall, Kenneth, Supt., East Genesee Water Dist., Box 63, Fayetteville, N.Y. (Apr. '54) *MD*

Briskey, Joseph A., Owner & Operator, Pacific City Water System, Pacific City, Ore. (Apr. '54) *MR*

Camillus Water Dist., Lewis Cross, Supt., 204 Melrose Ave., Syracuse 9, N.Y. (Corp. M. Apr. '54) *M*

Carlson, Donald R., Chemist, Topeka Water Dept., Topeka, Kan. (Apr. '54) *P*

Carrier, Sherman William, Supt., Water & Sewer Dept., Muskegon Hts., Mich. (Apr. '54) *PD*

Clark, Lawrence E., Mgr., Munic. Utilities, Broken Bow, Neb. (Apr. '54) *MRD*

Clark, Louis F., Distr. Supt., New York Water Service Corp., 20 East Ave., Rochester, N.Y. (Apr. '54) *D*

Cleasby, John L., Student & Instructor, Civ. Eng. Dept., 215 Eng. Annex, Iowa State College, Ames, Iowa (Jr. M. Apr. '54) *RP*

Cobleskill Water Dept., Robert J. Eakin, Supt., 15 East Street, Cobleskill, N.Y. (Munic. Sv. Sub. Apr. '54) *PD*

Cohn, Morris M., Editor, Case-Shepperd-Mann Publishing Corp., 24 W. 40th St., New York 18, N.Y. (Apr. '54) *MRPD*

Cross, Lewis; *see* Camillus (N.Y.) Water Dist.

Crow, Robert L., City Engr., Municipal Bldg., 155 S. Seward St., Juneau, Alaska (Apr. '54) *RPD*

Cunningham, George M., Dist. Sales Mgr., Industrial Chemicals Div., Mathieson Chemical Corp., 2535 Eastland Ave., Los Angeles 22, Calif. (Apr. '54) *P*

Cunningham, Wesley William, Service Mgr., Harris Pump & Supply Co., Pittsburgh, Pa. (Apr. '54) *RP*

Dan River Mills, Inc., H. C. Jones, Filter Plant, Schoolfield Div., Danville, Va. (Corp. M. Apr. '54)

Davenport, Charles F., Asst. Supt., Water Works, 214 S. Main St., Greenville, S.C. (Apr. '54) *M*

Doyle, Charles L., Asst. Supt., Water Dept., Newburgh, N.Y. (Apr. '54) *MD*

Dyce, Quentin, Repr., Denver Fire Clay Co., 2406 Meadowood, Billings, Mont. (Apr. '54) *P*

Eakin, Robert J.: *see* Cobleskill (N.Y.) Water Dept.

Earhart, Harold M., Supt. of Utilities, Troy, Kan. (Apr. '54) *MP*

East Rochester, Village of, Eric W. Waller, Supt. of Public Works, East Rochester, N.Y. (Munic. Sv. Sub. Apr. '54) *MD*

Edmonds, John F.; *see* Kitsap Lake (Wash.) Water Dist.

Ellensburg Water Dept., Edward N. Allenbaugh, Utilities Supt., Ellensburg, Wash. (Munic. Sv. Sub. Apr. '54) *MD*

Elliott, Marshall, Utility Engr., Gulf Oil Corp., Port Arthur, Tex. (Apr. '54) *P*

Emerson, Arthur H., Cons. Engr., 442 Flower Bldg., Watertown, N.Y. (Apr. '54) *MRPD*

Enterprise, City of, Arthur O. Gates, Supt. of Utilities, Enterprise, Kan. (Corp. M. Apr. '54) *MP*

Fairbanks Municipal Utilities System, Frank H. Mapleton, Gen. Mgr., 122 Noble St., Fairbanks, Alaska (Munic. Sv. Sub. Apr. '54) *MPD*

Felt, Lowell W., Civ. Eng. Assoc., Dept. of Water & Power, 3669 Terminal Annex, Room 859 Hill St. Bldg., Los Angeles 54, Calif. (Apr. '54) *M*

Ferraro, Raymond, Supt., Town Hall, Chapel St., Mt. Morris, N.Y. (Apr. '54) *P*

Finkbeiner, Jack E., Partner, E. A. Finkbeiner, 609 Lewis Bldg., Portland 4, Ore. (Apr. '54) *RD*

Flegal, George B., Jr., Engr.-Mgr., Water Com., Box 852, Morgantown, W.Va. (Apr. '54) *M*

Fore, Charles B., Partner, Bud Fore Meter Repair Service, 11402 Sunset Blvd., Renton, Wash. (Apr. '54)

Fore, Charles K., Partner, Bud Fore Meter Repair Service, 11402 Sunset Blvd., Renton, Wash. (Apr. '54) *D*

Gallaher, Hugh M., Albert A. Webb Assocs., 3788 McCray St., Riverside ,Calif. (Apr. '54)

Galvin, Marvin G., Field Engr., Fairbanks, Morse & Co., Box 976, Muskogee, Okla. (Apr. '54) *MR*

Gardner, Roy L., Cons. Engr., Gardner & Hitchings, 613 Arctic Bldg., Seatle 4, Wash. (Apr. '54) *PD*

Gates, Arthur O.; *see* Enterprise (Kan.)

George, Kenneth R., Sales Engr., Meter & Valve Div., Rockwell Mfg. Co., 614 Pine St., Lancaster, Ohio (Apr. '54) *MRP*

Gilbert, Glenn B., Service & Sales Engr., Wallace & Tiernan, 418 Flannery Bldg., Pittsburgh, Pa. (Apr. '54) *P*

Glenn, Robert F., Supt. of Distr. Repairs, Dept. of Water Supply, Gas & Electricity, 105 W. 96th St., New York, N.Y. (Apr. '54) *PD*

Gormley, Frederick, Chief Chemist, Pan American Sulphur Co., 1223 Commerce Bldg., Houston, Tex. (Apr. '54) *MP*

Grabbit, David F., Asst. Supt., Box 41, Wilson, N.Y. (Apr. '54) *MPD*

Greenwood, P. H., Salesman, Barada & Page, Inc., 26 N. Guthrie, Tulsa, Okla. (Apr. '54) *P*

Gurtlinger, John J., Dist. Sales Repr., Inertol Co., Inc., 1645 Research Ave., New York 61, N.Y. (Apr. '54) *MRPD*

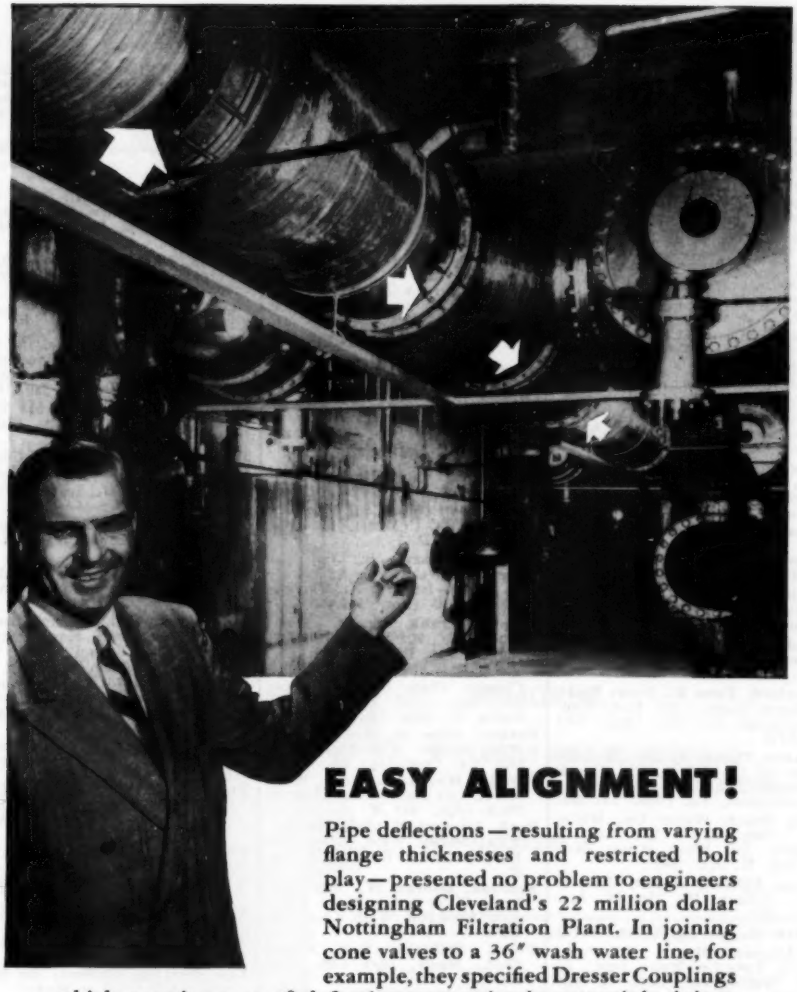
Harper, C. N., City Engr., Osage City, Kan. (Apr. '54)

Helbock, Carl E., Field Repr., Geo-Research, 1331–1333 E. Colvin St., Syracuse 10, N.Y. (Apr. '54) *R*

Henry, James E., Supt., Water Dept., 419—5th St., Pipestone, Minn. (Apr. '54) *MRPD*

Hill, Allen E., Partner, Parker, Hill & Ingman, 1728 E. Madison St., Seattle 22, Wash. (Apr. '54) *RPD*

(Continued on page 78 P&R)



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Hitzrot, Henry W., Special Asst. for Eng. Sales, Dorr Co., Barry Pl., Stamford, Conn. (Apr. '54) *RP*

Hogan, Donald A., San. Sales Engr., H. D. Fowler Co., Inc., Box 3084, 901 Lane St., Seattle 14, Wash. (Apr. '54) *MD*

Humes, R. W.; *see* Sherman Products, Inc.

Hutton, Joseph J.; *see* Thomas & Hutton, Engrs.

Igoe, James C., Foreman, Water Treatment Plants, U.S.A.F., Box 2081, Fairbanks, Alaska (Apr. '54) *MP*

Jensen, Carroll M., Supt. of Municipal Utilities, Sleepy Eye, Minn. (Apr. '54) *PD*

Johnson, Dale M., Chemist, Munic. Purif. Plant, 528 N. Erie, Wichita, Kan. (Apr. '54)

Jones, H. C.; *see* Dan River Mills, Inc.

King County Water Dist. No. 64, Merle C. Landreth, Supt., 30815—18th Ave. S., Auburn, Wash. (Corp. M. Apr. '54) *M*

Kitsap Lake Water Dist., John F. Edmonds, Chairman, Route 1, Box 1919, Bremerton, Wash. (Munic. Sv. Sub. Apr. '54) *MD*

Kuehne, Otto W., Supt., Water Works, Box 44, Long Prairie, Minn. (Apr. '54) *MP*

Landreth, Merle C.; *see* King County (Wash.) Water Dist. No. 64

Langford, Leon E., Design Engr., Chester Engrs., 210 Park Way, Pittsburgh 12, Pa. (Apr. '54) *MRPD*

Lawson, Claude S., Pres. & Chairman of the Board, U.S. Pipe & Foundry Co., 3300—1st Ave. N., Birmingham, Ala. (Apr. '54) *MR*

Long Beach Water Co., Walter C. Sharp, Supt., Bay Ave. & Amber St., Beach Haven, N.J. (Corp. M. Apr. '54)

Lopez, Alfredo, Student, Univ. of Ill., Urbana, Ill. (Jr. M. Apr. '54) *RP*

Maber, J. A.; *see* Nelson (B.C.)

MacLennan, Harry P., Supt., Troy Township Water Dept., 60 W. Wattles Rd., Route 4, Birmingham, Mich. (Apr. '54) *MRD*

Manger, John P., Sales Engr., Infilco Inc., 233 Hunter St., Battle Creek, Mich. (Apr. '54) *P*

Mapleton, Frank H.; *see* Fairbanks (Alaska) Municipal Utilities System

Marsh, Amos B., Plant Chemist, El Dorado Refining Co., Box 551, El Dorado, Kan. (Apr. '54) *MD*

McArthur, Charles E., Jr., Special Repr., Kansas City Suburban Water Co., 5916 Dearborn, Mission, Kan. (Apr. '54) *M*

McCaffery, Edward I., Cons. Engr., 216 Albany Ave., Kingston, N.Y. (Apr. '54) *MRPD*

McCann, Richard W., Mgr., Lakewood Water Dist., 11900 Gravelly Lake Dr., Tacoma 99, Wash. (Apr. '54) *M*

Melendez Fresnedo, Juan L., Civ. Engr., Direccion de Acueductos y Alcantarillados, Comision de Fomento Nacional, Linea #959 Vedado, Havana, Cuba (Apr. '54) *MRPD*

Merriton Water Works, Robert Van Buskirk, Supt., 24 Hudson St., Homer, N.Y. (Munic. Sv. Sub. Apr. '54) *D*

Milam, H. Stuart, Petroleum Engr., Phillips & Milam, 604 S. Vine St., Chelsea, Okla. (Apr. '54) *MP*

Mosely, Marvin A., Asst. Supt., Maint. & Constr., Portland Water Bureau, 1900 N. Interstate Ave., Portland 12, Ore. (Apr. '54) *D*

Mount Gilead Board of Public Affairs, Lyle Snair, Supt. of Water Works, Mount Gilead, Ohio (Corp. M. Apr. '54)

Murphy, Henry F., Asst. Engr., Maurice L. Miller, Cons. Engrs., 205 S. Floyd St., Louisville, Ky. (Apr. '54) *MRD*

Nelson, City of, J. A. Maber, Water Works Supt., 501 Front St., Nelson, B.C. (Munic. Sv. Sub. Apr. '54) *MD*

Northen, Charles S., Jr., Vice Pres., Sales, U.S. Pipe & Foundry Co., 3300—1st Ave. N., Birmingham 2, Ala. (Apr. '54) *R*

O'Dell, Frank, Special Repr., Mueller Co., 205 W. Wacker, Rm. 206, Chicago, Ill. (Apr. '54) *D*

Pantalone, Joseph A., Chief Chemist, Chase Brass & Copper Co., Inc., 1260 E. 260th St., Euclid 17, Ohio (Apr. '54) *P*

Parker, John E., Asst. to Sales Mgr., Dresser Mfg. Div., Bradford, Pa. (Apr. '54) *M*

Paullin, Wyman L., Supt., Water Works, City Hall, Mount Pleasant, Mich. (Apr. '54) *M*

Peak, Edward E., Asst. Foreman, Water Supply, Water Dept., City Hall, Bremerton, Wash. (Apr. '54) *P*

Pearson, George W., Mgr., Gilberton Water System, Route 5, Box 1036, Bremerton, Wash. (Apr. '54) *MPD*

Pinta, William, Supt., Water Dept., Manly, Iowa (Apr. '54) *MP*

Port Washington Water Dist., Edward J. West, Chairman of the Board, 163 Main St., Port Washington, N.Y. (Corp. M. Apr. '54) *MRPD*

Powers, Charles B., Water Supt., 6630 Glenview Dr., Tinley Park, Ill. (Apr. '54) *M*

Queneau, Roland B., Latin-American Mgr., Pitometer Assocs., Inc., Casilla 1305, Guayaquil, Ecuador (Apr. '54)

Ratner, Robert A., Supt. of Institutes & Asst. Prof. of Mech. Eng., University Extension, 101 Arch Hall, Univ. of Neb., Lincoln, Neb. (Apr. '54) *MRPD*

Reid, E. E.; *see* Alabama League of Municipalities

Rodenburg, George B., Project Engr., Infilco Inc., Box 5033, Tucson, Ariz. (Apr. '54) *P*

Rolston, William Harold, Director, Associated Engineering Services Ltd., 1934 W. Broadway, Vancouver 9, B.C. (Apr. '54) *MRPD*

Sanford, Gordon K., Supt., Water Dept., City Hall, Oelwein, Iowa (Apr. '54) *M*

Scheuber, Donald H., Grade III Operator, Montrose Improvement Dist., Montrose, N.Y. (Apr. '54) *MRPD*

Schulte, Eugene, Pres., Ferrostaal Overseas Corp., 25 Broadway, New York 4, N.Y. (Apr. '54) *PD*

Sharp, Walter C.; *see* Long Beach (N.J.) Water Co.

Sherman Products, Inc., R. W. Humes, Adv. & Sales Promotion Mgr., 3200 W. 14 Mile Rd., Royal Oak, Mich. (Assoc. M. Jan. '54)

Simmons, Thomas W., 611 Wilshire Blvd., Los Angeles, Calif. (Apr. '54)

Snair, Lyle; *see* Mount Gilead (Ohio) Board of Public Affairs

Spahn, Hubert H., Supt. of Utilities, Chester, Neb. (Apr. '54) *D*

Starks, Burley H., Supt. of Water, Box 381, Cottonwood Falls, Kan. (Apr. '54) *M*

Storms, Frederick, Supt., Public Works, Sloatsburg, N.Y. (Apr. '54) *D*

Stutz, Charles L., Research Assoc., League of Kansas Municipalities, 512 Capitol Federal Bldg., Topeka, Kan. (Apr. '54) *MRP*

Sutton, Reginald A., Supt., Mount View Edgewood Water Co., 4408 N. Meridian, Puyallop, Wash. (Apr. '54) *MD*

Taylor, Harvey W., San. Engr., Morrison & Maierle Inc., Helena, Mont. (Apr. '54) *MPD*

Thomas, W. B., Staff Engr., Carbide & Carbon Chemicals Co., South Charleston, W.Va. (Apr. '54) *MRPD*

Thomas & Hutton, Engrs., Joseph J. Hutton, Partner, 20 E. Bay Street, Box 1043, Savannah, Ga. (Corp. M. Apr. '54) *MP*

Tudor, Thomas J., Water Chlorination Service Co., 16811 W. Riverdale Dr., Detroit 19, Mich. (Apr. '54) *RP*

Van Buskirk, Robert; *see* Merriton (N.Y.) Water Works

Waller, Eric W.; *see* East Rochester (N.Y.)

Wally, L. W., Supt., Water Works, Box 613, Cedartown, Ga. (Apr. '54) *MP*

Walsh, Kevin R., Draftsman, Water Dept., 425 Mason St., San Francisco 1, Calif. (Apr. '54) *M*

Warrington, Frank C., Contracting Engr., Pittsburgh-Des Moines Steel Co., 1015 Tuttle St., Des Moines, Iowa (Apr. '54)

Webb, Thomas A., County Highway Engr., St. Joseph Co. Road Com., Centreville, Mich. (Apr. '54) *PD*

West, Edward J.; *see* Port Washington (N.Y.) Water Dist.

Wilson, Arthur W., Sales Chemist, Stauffer Chemical Co., Box 68, North Portland, Ore. (Apr. '54) *P*

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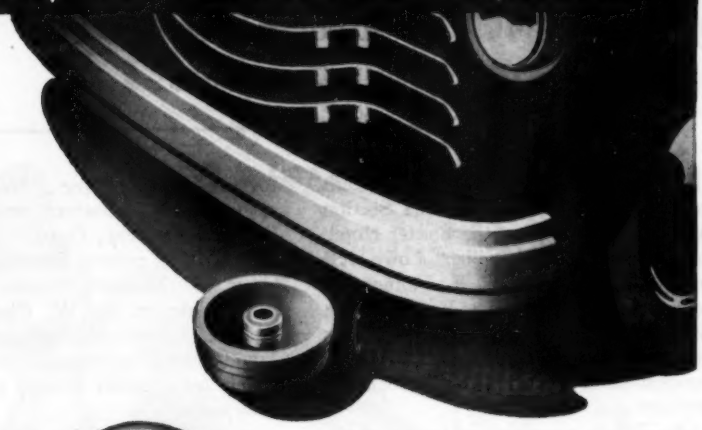

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The Smith Protectop Hydrant is designed to permit rapid return to service at minimum cost when a Hydrant is damaged as a result of a traffic accident.

The Protectop Hydrant Standpipe and Valve Stem are equipped with *Special Couplings* located just above the ground. The Couplings withstand operating pressures and ordinary impact with an ample factor of safety. Under excessive impact occasioned by traffic accidents the Couplings fracture at the design points thus minimizing the damage and permitting speedy return to service at low cost.

All Smith Hydrants are equipped with Compression Type Valves which definitely eliminate flooding since the line pressure holds the Valve against its seat in the closed position.

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38

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EAST ORANGE, NEW JERSEY

Section Meetings

Montana Section: The Twenty-Ninth Annual Meeting of the Montana Section was held April 23–24 at the Baxter Hotel, Bozeman. Mayor W. Gilbert Lowe welcomed the members; F. F. Palmer responded; Chairman Chet Eyer gave a brief address; the Secretary gave his annual report; and Dale Maffitt, AWWA president-elect, reported on association activities.

John Sasek, executive secretary of the Public Employees Retirement System of Montana, discussed public employees' benefits.

A luncheon meeting was held on Friday afternoon. P. C. Gaines, vice-president of Montana State College, and others discussed the Cobleigh Memorial Fund, established by the joint efforts of the Montana Sewage and Industrial Wastes Assn., the Montana Society of Professional Engineers, and the Montana Section of AWWA, to honor the memory of Dean W. M. Cobleigh of Montana State College. Dean Cobleigh was one of the founders of the section and had devoted his life to the improvement of the water works profession. Dale Maffitt then spoke on the development of the Missouri River Basin Commission, of which he is a member.

At the Friday afternoon session, a round table discussion was led by John Dennis, vice-chairman of the section, and C. W. Brinck, M. E. Henderson, John B. Hazen, and Richard Setterstrom participated.

New officers elected at the business meeting were: John Dennis, city engineer of Laurel, chairman; John Morrison, Morrison-Maierle, Inc., Helena, vice-chairman; Ben Chestnut, superintendent of the Water Dept., Great Falls, trustee; R. G. Cronin, general foreman, Montana Power Co., Missoula, trustee. The secretary-treasurer, A. W. Clarkson, was reappointed to serve for the ensuing year. Claude Eyer, city engineer of Glendive, was elected national director for the next three years.

On Saturday morning "The Effect of Beaver on the Quality of Creek Water" was discussed by George Malben, superintendent of the Water Dept., Helena, and H. B. Foote, Helena. This study indicates that the presence of beaver on a watershed greatly increases the bacteriological pollution in the water. The water also develops a certain amount of color and organic pollution in going through the beaver impoundments. As the water leaves the impoundments and again flows through the rocky channel with a rapid fall, and is supplemented by the spring flow from underground sources, the bacteriological load decreases.

The second address was given by Dave Thomas, inspecting engineer of the Board of Fire Underwriters of the Pacific, Great Falls, whose topic was "Water Works Safety." He pointed out that there are very few water utilities in the country that are actually keeping records of accidents and accident frequency, and still fewer that are reporting these accidents to the national agencies. He recommended that for a successful accident prevention program in an organization, complete records should be kept of all accidents, especially lost-time accidents.

(*Continued on page 82 P&R*)

IT SAYS HERE - "A JONES ENGINEERED BRONZE SERVICE STOP WILL UPLIFT THE DEPARTMENT MORALE."
WATER DEPT.
EST. 1892
JAMES JONES COMPANY
321 N. TEMPLE CITY BLVD. • EL MONTE, CALIF.
Bronze Goods for: WATER SERVICE
Gas Service • Oil Service • Fire Protection

Section Meetings

(*Continued from page 80 P&R*)

As Hugh Potter, state civilian defense director, was unable to appear to speak on civilian defense in its relation to water supplies, he sent the recently released film on the H Bomb, "Operation Ivy," which was shown to the group.

The remainder of the program was made up of social activities. A special noon luncheon for the ladies on Friday, a cocktail party, banquet and dinner-dance on Friday evening. The George Warren Fuller Award nomination went to M. E. Henderson, city manager of Bozeman.

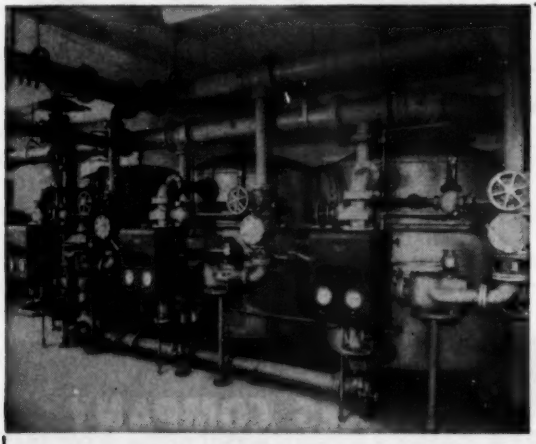
A. W. CLARKSON
Secretary-Treasurer

New York Section: The Annual Spring Meeting of the New York Section was held at the Hotel Woodruff, Watertown, on Apr. 22–23. The total registration was 302, a record high for the spring session.

On Thursday morning, an inspection trip to the New York Air Brake Plant proved to be educational and interesting. George E. Symons later conducted a discussion entitled "Introduction to Water Works Practice." As a series of water works practice schools is projected, the form which they will take at future meetings was discussed. The schools will be held the first morning of every section meeting.

Mayor John H. Newman of Watertown officially opened the meeting at the luncheon on Thursday, with an address of welcome. Maxim Lieber, associate sanitary chemist, Div. of Laboratories and Research, Nassau County Dept. of Health, and W. Fred Welsch, senior engineer, Div. of Sanitation, Nassau County Dept.

(*Continued on page 84 P&R*)



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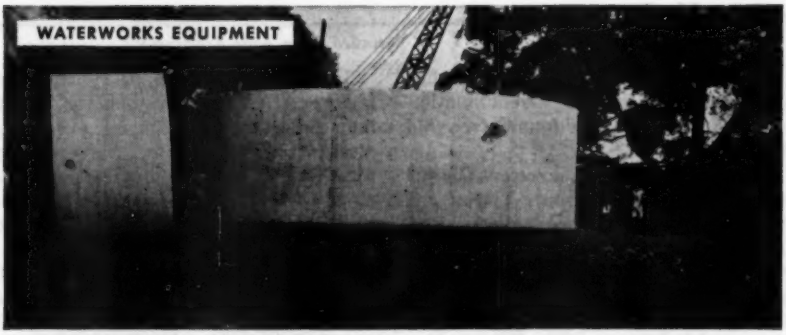

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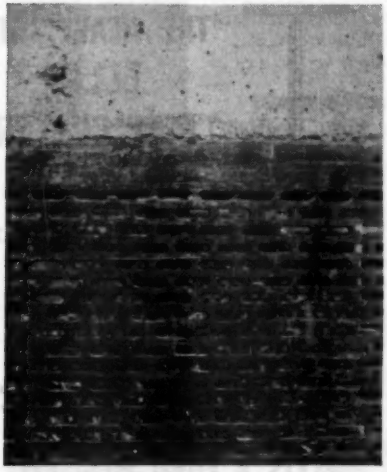
Durable well screens made of Everdur feature modern N. J. water system

Corrosion-resistant Everdur* was used for the screens in the 6 caisson wells that supplement the water supply of Manville, N. J. Everdur—the ideal material for well screens—was a big factor in permitting the use of this type of water system.



Made of ¼-inch-thick Everdur plate, circular screens are 18 inches high, having ¼-inch oblong perforations. Total open area is about 37%.

Caisson Wells, Inc., of New York City, did the job. Jordan S. Asketh of this company conducted the exploratory work. Wallace M. Graves, Consulting Engineer, Bound Brook, N. J., was in charge. Edward Purzicki was Waterworks Superintendent.

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COPPER-SILICON ALLOYS

Strong • Weldable • Workable

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Section Meetings

(Continued from page 82 P&R)

of Public Works, delivered the opening paper, which was entitled "Contamination of Ground Water by Cadmium" (see this issue, p. 541).

Terrance McCormack, director, Div. of Sanitation, Nassau County Dept. of Health, delivered an interesting talk on "The Need for Operator Training." He mentioned that a high percentage of unqualified personnel are operating water plants in New York. Schools and training courses have been developed and are available to those who wish to increase their qualifications. Raymond J. Faust, AWWA executive assistant secretary, continued the discussion with a short talk on "Management of Publicly Owned Water Works." The afternoon program was concluded with an interesting paper by A. A. Baskous, Bureau of Sanitation, Albany, entitled "Civil Defense Aspects of Water Supply Planning."

The Water and Sewage Works Manufacturers Assn. sponsored the cocktail hour preceding the banquet, providing a pleasant opportunity for everyone to get together. Following the banquet, Raymond J. Faust presented Life Membership certificates to Clinton L. Bogert, Roy W. Gausmann, Frederick R. Georgia, F. Wellington Gilcreas, Harry B. Miles, Warren C. Taylor, and Leonard P. Wood. It was also announced by the incoming chairman, Simon P. Carman, that John M. Diven was elected by the membership as the new trustee for the section. The guest speaker of the evening was Lewis K. Sillcox, president of the American Society of Mechanical Engineers, who spoke on "The Problem of Water."

On Friday, after a hearty North Country breakfast, the Round Table Conference was led by S. P. Carman, consulting engineer of Binghamton. Thomas M.

(Continued on page 86 P&R)

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Assure positive drainage.

Are available for any type of connection.

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Section Meetings

(Continued from page 84 P&R)

Riddick, consultant of New York, gave an outstanding talk on "The New York State Thruway and Water Works Relocations" (*see* this issue, p. 503), and following his talk discussions were heard on cold weather service problems, use of trenching machines for service installations, and control of fluoridation.

KIMBALL BLANCHARD
Secretary-Treasurer

California Section: The Seventh Annual Spring Regional Meeting of the California Section was held Friday, April 9, 1954, at Monterey, in the House of Four Winds, the history of which dates back to early mission days. The meeting attracted 325 registrants, including 74 ladies. An optional field trip to points of interest in the vicinity was also held on Saturday. H. Christopher Medbery, chairman, introduced Mayor Dan Searle, who welcomed the members and their guests.

The first paper, presented by U. F. McElroy, division engineer, California Water & Telephone Co., described the design and problems of the Monterey water system. This paper was discussed and elaborated on by E. S. Germain, public relations officer for the California company.

"Engineering Assistance Available to Utility Management" was discussed by John C. Luthin, consultant of Santa Cruz. He advised keeping the following records as an aid to successful planning:

1. A continuous record of the number of customers served.
2. Water consumption, by months, from customer meter records.
3. Records of the capacities of wells, streams, and treatment and pumping plants.

(Continued on page 88 P&R)

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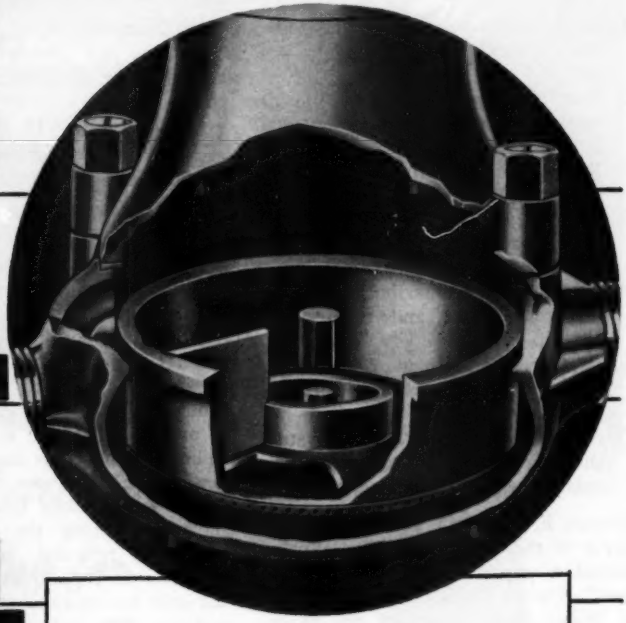

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Section Meetings

(Continued from page 86 P&R)

4. Records of actual outputs of wells, streams, and treatment plants and pumps.
5. Records showing the time of operation of intermittently operated facilities.
6. Records of flow requirements for maximum month, day, and hour.
7. Distribution system maps and records as suggested by the AWWA C900 standard.
8. A map of the distribution system on which leaks and repairs are plotted.
9. Pressure charts made at strategic points with all pertinent data recorded.
10. A map of the distribution system showing the proposed long-range enlargement and expansion plans.

Norman E. Andrews, assistant general manager of the San Jose Water Works, presented a paper on "Customer Complaints." Carrol Clark of the San Francisco Water Dept. discussed the paper.

The afternoon session consisted of a Water Works Clinic, with E. A. Reinke, chief bureau sanitary engineer, State Dept. of Public Health, as interlocutor. The panel consisted of: J. E. McKee, associate professor of sanitary engineering, California Institute of Technology; Erman A. Pearson, assistant professor of sanitary engineering, University of California at Berkeley; William C. Renshaw, water engineer and superintendent, Water Dept., Inglewood; Arthur Webb, safety coordinator, East Bay Municipal Utility Dist., Berkeley; Weston L. Webber, superintendent of water, Santa Cruz; and W. C. Welmon, secretary-treasurer, Southern California Water Co., Los Angeles.

The Spring Meeting Dinner was held at the Monterey County Fair Grounds just outside of Monterey on Friday night and was attended by 242 persons. The ladies enjoyed a luncheon at the Carmel Highlands Lodge in the Carmel Valley and a visit to the unique shops of Carmel.

On Saturday, April 10th, there was a trip to the San Clemente Dam and Filter Plant of the California Water & Telephone Co.

H. F. JERAULD
Secretary-Treasurer

Kansas Section: The ninth annual joint meeting of the Kansas Section and the Kansas Sewage & Industrial Wastes Assn. began with a general session the afternoon of April 7 at the Broadview Hotel, Emporia. E. W. Powell, city engineer, Concordia, introduced the first speaker, John Dawson of Oklahoma A & M College, who used apparatus he had brought with him to show causes of loss in pressure and also to show how back-siphonage and cross connections can contaminate entire water supplies.

The round table discussion of water shortages during the drought of 1953 and 1954 revealed, according to City Engineer C. N. Harper, that Osage City has only two months' supply in the river, and rain is the only answer to their problems. At Yates Center, the wells which produce 15–18 gpm were reported as being good by superintendent Don Vaughn. City Manager John B. La Duex, Russell, placed emphasis on the extremely high rate which the city has been forced to pay for water released from the Cedar Bluff reservoir of the Bureau of Reclamation.

City Engineer L. A. Martindale, El Dorado, reported less than 0.25 mgd available in the Walnut River. If strict conservation methods had not been used and water not been obtained from Wichita and from Fox Lake, El Dorado's reservoir supply would probably have been depleted two months ago. Martindale stated that the 210 mil gal had cost $330,000, with the oil refineries paying all the costs. Voluntary rationing cut the use to 20 gpcd. A contract was entered into with Weather Modification Corp. for cloud seeding, with no measurable results to date. The refineries have also paid for most of the cost of cloud seed-

(Continued on page 90 P&R)

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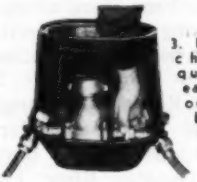

3. Meter changes quick and easy, without cumbersome tools.

4. Service valve easily operated and well protected.

FORD

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Section Meetings

(Continued from page 88 P&R)

ing. Rain seems to be the only answer to the problem here. City Engineer Paschal Grimes, Chanute, stated that more water is required by the city than is coming down the river, so pumps have been set in holes upstream and the water pumped over the riffles to reach the intake. City Engineer R. W. Cunningham, Emporia, reported that severe ordinances have been passed restricting the use of water to essential purposes only. Water for street and sewer flushing is being hauled, and treated water is no longer available for hauling by ranchers and stockmen.

On Thursday morning, April 8, City Manager Walter F. Johnson gave a most gracious welcome to those attending the convention. President Morrison B. Cunningham and H. H. Kansteiner, director from the Kansas Section, brought greetings from AWWA. The paper "Conservation of Water Used in Air Conditioning" by C. K. Mathews of Burns & McDonnell Engineering Co. was well received and evoked long and lively discussion.

In the afternoon, A. O. Putnam, Director of Public Relations, Layne & Bowler, Inc., Memphis, Tenn., used a large number of interesting slides to illustrate his very fine paper on "Public Relations—An Opportunity for Your Water Department." Keith R. Barney, district engineer, Corps of Engrs. and Marion E. Ball, projects hydrologist, Bureau of Reclamation (Kansas River Projects) discussed the water development plans of the two organizations and their effects on public water supplies. Murray A. Wilson, consulting engineer, Salina, reviewed the water supply situation in Kansas. Discussion of the points raised by the speakers was so lively that it was with considerable difficulty that Presider Orville Kuran brought the meeting to a conclusion shortly before 6 PM. Section Chairman Robert S. Millar, manager, Wichita Water Co., most capably presided at the banquet meeting. The section's Certificate of Award to Past Chairmen was presented to Robert J. Mounsey, superintendent, Lawrence. Dwight Fox Metzler, chief engineer and director, Div. of Sanitation, State Board of Health, was nominated to receive the George Warren Fuller Award for 1954. Ray Bounous of the Wichita Chamber of Commerce gave a light, humorous, yet thoughtful talk, "The Truth about Kansas."

On Friday morning, with Ben J. Brungardt, city manager, Hays, presiding, Harold R. Volkmann, superintendent, Clay Center, and Kenneth G. Bittel, city clerk, Abilene, related the experiences of their cities in adopting department ownership of water meters. The discussion which followed brought out that apparently only one superintendent present was not in favor of having the ownership of the meters transferred from the customers to the water department. Darwin R. Soder, district manager, Layne-Western Co., Wichita, gave a comprehensive talk on "Pump Maintenance."

The final technical session was devoted to the question, "Are Your Water Rates Adequate?" Moderator B. H. Van Blarcum, superintendent, Manhattan, read a paper outlining his experience with raising water rates. Robert Mounsey and Ben Brungardt discussed the rate structure and rates of their respective cities of Lawrence and Hays.

At the business meeting immediately following the Friday luncheon, reports of the various committees were heard and approved. The section voted to institute a program of voluntary certification of water works operators in Kansas. The report of the nominating committee was accepted as presented, and the following officers were elected for the ensuing year: Chairman—Orville G. Kuran, superintendent of distribution Mains, Kansas City; Vice-Chairman—G. Dorr Pelton, superintendent, Water Dept., Topeka; Trustee—E. W. Powell, city engineer, Concordia; Secretary-Treasurer—Harry W. Badley, Neptune Meter Co., Salina.

HARRY W. BADLEY
Secretary-Treasurer

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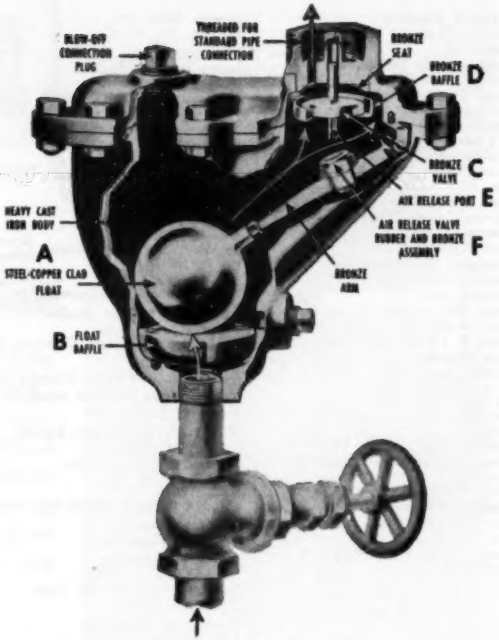

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It is used extensively for water mains, turbine pump discharge, bowls of booster pumps, air tanks and sand traps.

This valve will positively close under low water head, cannot blow shut and allows full and clear passage of air.

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It is available in simplified form for air release only. Ask for bulletin No. F. 106C

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(See Prof. Services, pp. 25–29)

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Filtration Plant Equipment:
Chain Belt Co.
Cochrane Corp.
Filtration Equipment Corp.
General Filter Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Infilco Inc.
F. B. Leopold Co.
Omega Machine Co. (Div., B-I-F Industries)
Permutit Co.
Roberts Filter Mfg. Co.
Stuart Corp.
Welsbach Corp., Ozone Processes Div.

Fittings, Copper Pipe:
Dresser Mfg. Div.
M. Greenberg's Sons
Hays Mfg. Co.
James Jones Co.
Mueller Co.

Fittings, Tees, Ells, etc.:
American Cast Iron Pipe Co.
American Locomotive Co.
Carlon Products Corp.
Cast Iron Pipe Research Assn.
James B. Clow & Sons
Crane Co.
Dresser Mfg. Div.
James Jones Co.
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
McWane Cast Iron Pipe Co.
Pacific States Cast Iron Pipe Co.
United States Pipe & Foundry Co.
R. D. Wood Co.

Flocculating Equipment:
Chain Belt Co.
Cochrane Corp.
Dorr Co.
General Filter Co.
Infilco Inc.
Permutit Co.
Stuart Corp.
Walker Process Equipment, Inc.

Fluoride Chemicals:
American Agricultural Chemical Co.
Blockson Chemical Co.
Henry Sundheimer Co.

Fluoride Feeders:
Builders-Providence, Inc.
Omega Machine Co. (Div., B-I-F Industries)
Wallace & Tiernan Co., Inc.

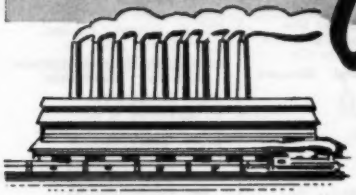
Furnaces:
Jos. G. Pollard Co., Inc.

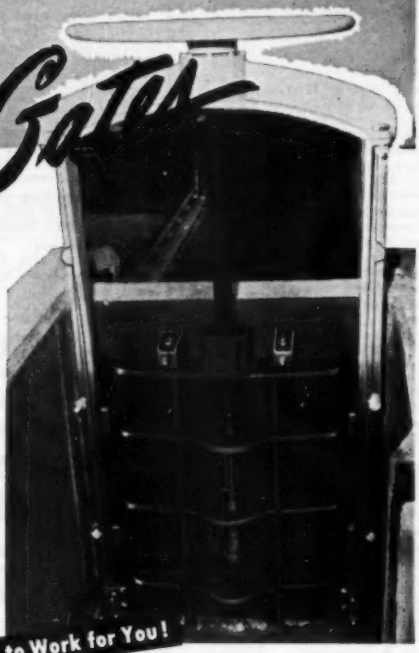
Gages, Liquid Level:
Builders-Providence, Inc.
Infilco Inc.
Simplex Valve & Meter Co.

Gages, Loss of Head, Rate of Flow, Sand Expansion:
Builders-Providence, Inc.
Infilco Inc.
Northrop & Co., Inc.
Simplex Valve & Meter Co.

Gasholders:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

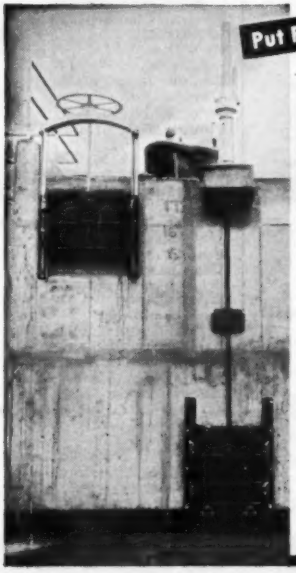
Pekrul Gates

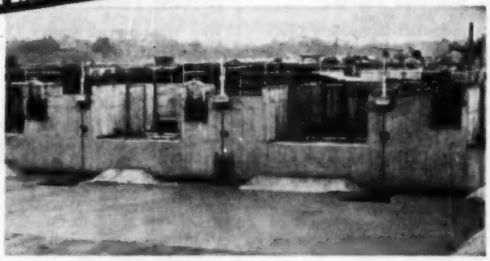




All sluice gates installed in the **United States Steel Corporation's** huge, new Fairless Works, Fairless Hills, Pa., were designed and manufactured by PEKRUL. Shown here are several gates among approximately 200 PEKRUL gates installed in pump stations and sedimentation basins.

Put PEKRUL to Work for You!





Write for Catalog 49...

PEKRUL GATE DIVISION

MORSE

BROS. MACHINERY

DENVER, COLORADO

Gaskets, Rubber Packing:
James B. Clow & Sons
Johns-Manville Corp.

Gates, Shear and Sluice:
Armco Drainage & Metal Products, Inc.
Chapman Valve Mfg. Co.
James B. Clow & Sons
Morse Bros. Mchy. Co.
Mueller Co.
R. D. Wood Co.

Gears, Speed Reducing:
DeLaval Steam Turbine Co.
Philadelphia Gear Works, Inc.

Glass Standards—Colorimetric Analysis Equipment:
Hellige, Inc.
Klett Mfg. Co.
Wallace & Tiernan Co., Inc.

Goosenecks (with or without Corporation Stops):
James B. Clow & Sons
Hays Mfg. Co.
James Jones Co.
Mueller Co.

Hydrants:
James B. Clow & Sons
Darling Valve & Mfg. Co.
M. Greenberg's Sons
James Jones Co.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Mueller Co.
Pacific States Cast Iron Pipe Co.
A. P. Smith Mfg. Co.
Rensselaer Valve Co.
R. D. Wood Co.

Hydrogen Ion Equipment:
Hellige, Inc.
Wallace & Tiernan Co., Inc.

Ion Exchange Materials:
Cochrane Corp.
General Filter Co.
Hungerford & Terry, Inc.
Infilco Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Rohm & Haas Co.

Iron Removal Plants:
American Well Works
Belco Industrial Equipment Div.
Chain Belt Co.
Cochrane Corp.
General Filter Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Infilco Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.
Welsbach Corp., Ozone Processes Div.

Jointing Materials:
Atlas Mineral Products Co.
Hydraulic Development Corp.
Johns-Manville Corp.
Leadite Co., Inc.

Joints, Mechanical, Pipe:
American Cast Iron Pipe Co.
Cast Iron Pipe Research Assn.
James B. Clow & Sons
Dresser Mfg. Div.
McWane Cast Iron Pipe Co.
Pacific States Cast Iron Pipe Co.
United States Pipe & Foundry Co.
R. D. Wood Co.

Leak Detectors:
Jos. G. Pollard Co., Inc.

Lime Sinkers and Feeders:
Dorr Co.
General Filter Co.
Infilco Inc.
Omega Machine Co. (Div., B-I-F Industries)
Permutit Co.

Magnetic Dipping Needles:
W. S. Darley & Co.

Meter Boxes:
Ford Meter Box Co.
Pittsburgh Equitable Meter Div.
Universal Concrete Pipe Co.

Meter Couplings and Yokes:
Badger Meter Mfg. Co.
Dresser Mfg. Div.
Ford Meter Box Co.
Hays Mfg. Co.
Hersey Mfg. Co.
James Jones Co.
Mueller Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
Welsbach Corp., Kitson Valve Div.
Worthington-Gamon Meter Co.

Meter Reading and Record Books:
Badger Meter Mfg. Co.

Meter Testers:
Badger Meter Mfg. Co.
Ford Meter Box Co.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.

Meters, Domestic:
Badger Meter Mfg. Co.
Buffalo Meter Co.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
Well Machinery & Supply Co.
Worthington-Gamon Meter Co.

Meters, Filtration Plant, Pumping Station, Transmission Line:
Builders-Providence, Inc.
Foster Eng. Co.
Infilco Inc.
Simplex Valve & Meter Co.

Meters, Industrial, Commercial:
Badger Meter Mfg. Co.
Buffalo Meter Co.
Builders-Providence, Inc.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
Simplex Valve & Meter Co.
Well Machinery & Supply Co.
Worthington-Gamon Meter Co.

Mixing Equipment:
Chain Belt Co.
General Filter Co.
Infilco Inc.
Walker Process Equipment, Inc.

Ozonation Equipment:
Welsbach Corp., Ozone Processes Div.

Pipe, Asbestos-Cement:
Johns-Manville Corp.
Keasbey & Mattison Co.

Pipe, Brass:
American Brass Co.

Pipe, Cast Iron (and Fittings):
American Cast Iron Pipe Co.
Cast Iron Pipe Research Assn.
James B. Clow & Sons
Crane Co.
McWane Cast Iron Pipe Co.
Pacific States Cast Iron Pipe Co.
United States Pipe & Foundry Co.
R. D. Wood Co.

Pipe, Cement Lined:
Cast Iron Pipe Research Assn.
James B. Clow & Sons
McWane Cast Iron Pipe Co.
Pacific States Cast Iron Pipe Co.
United States Pipe & Foundry Co.
Universal Concrete Pipe Co.
R. D. Wood Co.

Pipe Coatings and Linings:
The Barrett Div.
Cast Iron Pipe Research Assn.
Centriline Corp.
Koppers Co., Inc.
Reilly Tar & Chemical Corp.

Pipe, Concrete:
American Concrete Pressure Pipe Assn.
American Pipe & Construction Co.
Lock Joint Pipe Co.
Universal Concrete Pipe Co.

Pipe, Copper:
American Brass Co.

Pipe Cutting Machines:
James B. Clow & Sons
Ellis & Ford Mfg. Co.
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.

Pipe Jointing Materials; see Jointing Materials

Pipe Locators:
W. S. Darley & Co.
Jos. G. Pollard Co., Inc.

Pipe, Steel:
American Locomotive Co.
Armco Drainage & Metal Products, Inc.
Bethlehem Steel Co.

Plugs, Removable:
James B. Clow & Sons
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.

Potentiometers:
Hellige, Inc.

Pressure Regulators:
Allis-Chalmers Mfg. Co.
Foster Eng. Co.
Mueller Co.
Ross Valve Mfg. Co.

Pumps, Boiler Feed:
DeLaval Steam Turbine Co.

Pumps, Centrifugal:
Allis-Chalmers Mfg. Co.
American Well Works
DeLaval Steam Turbine Co.
Morse Bros. Mchy. Co.
C. H. Wheeler Mfg. Co.

Pumps, Chemical Feed:
Infilco Inc.
Proportioneers, Inc.
Wallace & Tiernan Co., Inc.

Pumps, Deep Well:
American Well Works
Layne & Bowler, Inc.

Pumps, Diaphragm:
Dorr Co.
Morse Bros. Mchy. Co.

Pumps, Hydrant:
W. S. Darley & Co.
Jos. G. Pollard Co., Inc.

Pumps, Hydraulic Booster:
Ross Valve Mfg. Co.

Pumps, Sewage:
Allis-Chalmers Mfg. Co.
DeLaval Steam Turbine Co.
C. H. Wheeler Mfg. Co.

Pumps, Sump:
DeLaval Steam Turbine Co.
C. H. Wheeler Mfg. Co.

Pumps, Turbine:
DeLaval Steam Turbine Co.
Layne & Bowler, Inc.

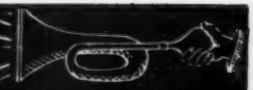
Recorders, Gas Density, CO_2, NH_3, SO_2, etc.:
Permutit Co.
Wallace & Tiernan Co., Inc.

Recording Instruments:
Infilco Inc.
Wallace & Tiernan Co., Inc.

Reservoirs, Steel:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Sand Expansion Gages; see Gages

YOU WERE DOING THIS



WHEN THE FIRST HYDRO-TITE JOINTS WERE BEING POURED -

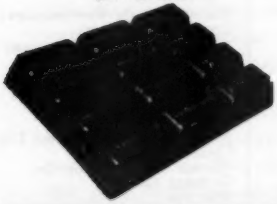
HYDRO-TITE
(POWDER)

HYDRO-TITE

(POWDER)

For over 40 years HYDRO-TITE has been faithfully serving water works men everywhere. Self-caulking, self-sealing, easy-to-use. Costs about 1/5 as much as lead joints. Packed in 100 lb. moisture-proof bags.

HYDRO-TITE
(LITTLEPIGS)



HYDRO-TITE

(LITTLEPIGS)

The same dependable compound in solid form —packed in 50 lb. cartons—2 litters of pigs to the box—24 easy-to-handle Littlepigs. Easier to ship, handle and store.

FIBREX
(REELS)

FIBREX

(REELS)

The sanitary, bacteria-free joint packing. Easier to use than jute and costs about half as much. Insures sterile mains and tight joints.

HYDRO-TITE

HYDRAULIC DEVELOPMENT CORPORATION

Sleeves; see Clamps

Sleeves and Valves, Tapping:
James B. Clow & Sons
M & H Valve & Fittings Co.
Mueller Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.

Sludge Blanket Equipment:
General Filter Co.
Permutit Co.

Sodium Hexametaphosphate:
Blockson Chemical Co.
Calgon, Inc.

Softeners:
Belco Industrial Equipment Div.
Cochrane Corp.
Dorr Co.
General Filter Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Infilco Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.

Softening Chemicals and Compounds:
Calgon, Inc.
Cochrane Corp.
General Filter Co.
Infilco Inc.
Permutit Co.
Tennessee Corp.

Standpipes, Steel:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Steel Plate Construction:
American Locomotive Co.
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Stops, Curb and Corporation:
Hays Mfg. Co.
James Jones Co.
Mueller Co.
Welsbach Corp., Kitson Valve Div.

Storage Tanks; see Tanks

Strainers, Suction:
James B. Clow & Sons
M. Greenberg's Sons
Johnson, Edward E., Inc.
R. D. Wood Co.

Surface Wash Equipment:
Cochrane Corp.
Permutit Co.

Swimming Pool Sterilization:
Everson Mfg. Corp.
Omega Machine Co. (Div., B-I-F Industries)
Proportioneers, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

Tanks, Steel:
American Locomotive Co.
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Tapping-Drilling Machines:
Hays Mfg. Co.
Mueller Co.
A. P. Smith Mfg. Co.

Tapping Machines, Corp.:
Hays Mfg. Co.
Mueller Co.
Welsbach Corp., Kitson Valve Div.

Taste and Odor Removal:
Cochrane Corp.
General Filter Co.
Industrial Chemical Sales Div.
Infilco Inc.
Permutit Co.
Proportioneers, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

Turbidimetric Apparatus (For Turbidity and Sulfate Determinations):
Hellige, Inc.
Wallace & Tiernan Co., Inc.

Turbines, Steam:
DeLaval Steam Turbine Co.

Turbines, Water:
DeLaval Steam Turbine Co.

Valve Boxes:
James B. Clow & Sons
Ford Meter Box Co.
M & H Valve & Fittings Co.
Mueller Co.
Pacific States Cast Iron Pipe Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valve-Inserting Machines:
A. P. Smith Mfg. Co.

Valves, Altitude:
Ross Valve Mfg. Co., Inc.

Valves, Butterfly, Check, Flap, Foot, Hose, Mud and Plug:
Backflow Engineering & Equipment Co.
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
DeZurik Shower Co.
M. Greenberg's Sons
M & H Valve & Fittings Co.
Mueller Co.
Rensselaer Valve Co.
R. D. Wood Co.

Valves, Detector Check:
Hersey Mfg. Co.

Valves, Electrically Operated:
Belco Industrial Equipment Div.
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Mueller Co.
Philadelphia Gear Works, Inc.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.

Valves, Float:
James B. Clow & Sons
Ross Valve Mfg. Co., Inc.

Valves, Gate:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
Dresser Mfg. Div.
James Jones Co.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Mueller Co.
Pacific States Cast Iron Pipe Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Hydraulically Operated:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
DeZurik Shower Co.
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Mueller Co.
Philadelphia Gear Works, Inc.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Large Diameter:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Mueller Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Regulating:
Crane Co.
DeZurik Shower Co.
Foster Eng. Co.
Mueller Co.
Ross Valve Mfg. Co.

Valves, Swing Check:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
M. Greenberg's Sons
M & H Valve & Fittings Co.
Mueller Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Waterproofing
Gulf States Asphalt Co.
Inertol Co., Inc.

Water Softening Plants; see Softeners

Water Supply Contractors:
Layne & Bowler, Inc.

Water Testing Apparatus:
Hellige, Inc.
Wallace & Tiernan Co., Inc.

Water Treatment Plants:
Allis-Chalmers Mfg. Co.
American Well Works
Belco Industrial Equipment Div.
Chain Belt Co.
Chicago Bridge & Iron Co.
Cochrane Corp.
Dorr Co.
General Filter Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Infilco Inc.
Permutit Co.
Pittsburgh-Des Moines Steel Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

Well Drilling Contractors:
Layne & Bowler, Inc.

Well Screens
Johnson, Edward E., Inc.

Wrenches, Ratchet:
Dresser Mfg. Div.

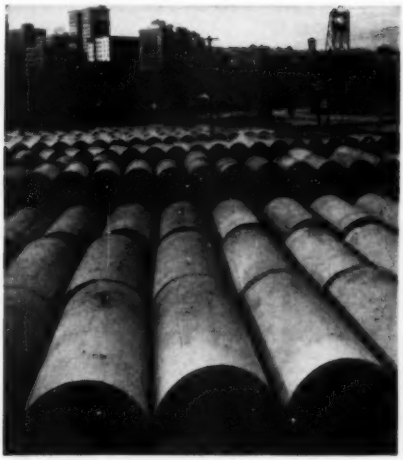
Zeolite; see Ion Exchange Materials

A complete Buyers' Guide to all water works products and services offered by AWWA Associate Members appears in the 1953 AWWA Directory.

TACOMA

PREFERS

Concrete Pressure Pipe



How does concrete pressure pipe stand up under extraordinary stress? Tacoma water authorities can tell you. Concrete pressure pipe installations in this northwest metropolis have been subjected to unusual strains from vibration, shock, heavy earth loads and serious earth tremors. No damage to the pipe resulted—a tribute to the strength and ruggedness of concrete pressure pipe.

Since 1928, approximately 160,000 feet of concrete pressure pipe have been laid in Tacoma and its surrounding area. Performance reports show that a minimum of maintenance has been necessary; that there has been no trouble due to electrolytic action, corrosion, or tuberculation.

When your community requires water transmission systems or distribution mains which must withstand unusually high stresses, install concrete pressure pipe. It has a proven record of performance under adverse conditions.

Member companies are equipped to manufacture and furnish concrete pressure pipe in accordance with established national specifications and standards.

Concrete PRESSURE Pipe

WATER FOR GENERATIONS TO COME

AMERICAN CONCRETE PRESSURE PIPE ASSOCIATION
228 North LaSalle Street
Chicago 1, Illinois

WE PLEAD GUILTY

To Improving Water Meter Performance

Chances are the meters you bought 20 or more years ago are costing you money way out of proportion to their revenue earning capacity. These old meters, even when new, could not approach the performance we're building into meters today.

We've worked constantly for improvement and our meters show it. Engineering, research and manufacturing have combined their talents to make Rockwell meters measure at top accuracy for longer periods at lower cost.

So think twice before again repairing a meter that creaks with age. Think first of the costs in parts and labor and weigh them against the cost of a new Rockwell. Then think of the greater revenue a new Rockwell will earn for you.

Let the Rockwell representative furnish proof that a planned program of meter replacement will so materially benefit your overall operations that it will more than pay for itself.

Rockwell Modern Meters For Modern Measurement Needs

ARCTIC Disc Type

TROPIC Disc Type

EMPIRE TYPE 12 Piston Type

EMPIRE TYPE 14 Piston Type

The Symbol for Service, Quality and Performance in Water Meters

ROCKWELL MANUFACTURING COMPANY

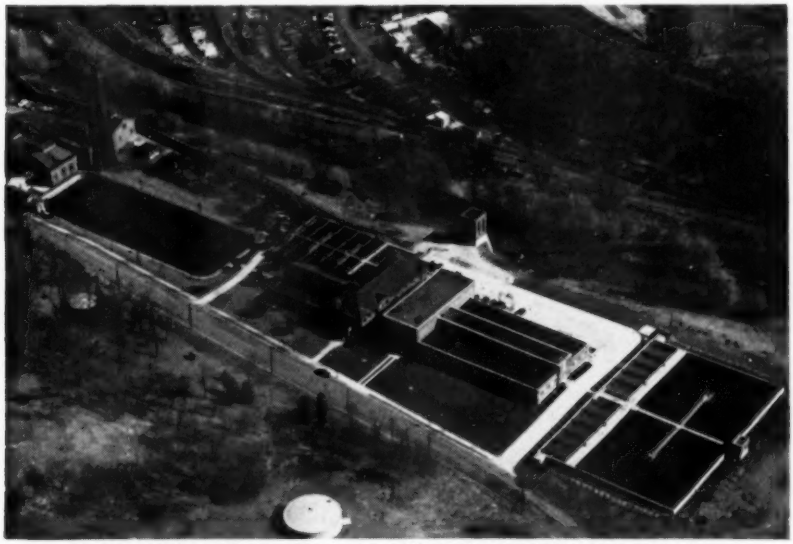
PITTSBURGH 8, PA. Atlanta Boston Chicago Houston
Los Angeles N. Kansas City New York Philadelphia
Pittsburgh San Francisco Seattle Tulsa

In Canada: Peacock Brothers Limited

in water treatment problems...

you won't find identical twins

No two water treatment problems are exactly alike. The right solution to each can only be arrived at after a careful study of the local conditions. Variables such as raw water composition, rate of flow and results required automatically rule out the cure-all approach. The installation shown below is a good example of how equipment should be selected to fit the job . . . and not vice versa.



Aerial view of the Allentown Plant. New additions are in the right foreground . . . original plant is behind the main building.

Allentown, Pennsylvania MODERNIZES EXISTING PLANT... ADDS NEW PLANT...

Faced with an expanding population and a badly overloaded water treatment plant, Allentown, Pa. called in Morris Knowles, Inc. of Pittsburgh, Pa. to design treatment facilities for 30 MGD. The Engineers first surveyed the existing facilities and found that effective use could be made of two rectangular plain sedimentation basins. Two Dorrco Flocculators, each with three rows of paddles, were installed at the head end of each basin in the twenty-five-year-old 10 MGD plant, thus greatly increasing the efficiency to prepare the water for settling and filtering. For the additional 20 MGD capacity the Engineers specified two more sets of Dorrco Flocculators to operate in combination with two SZ-7 Dorr Squarex Clarifiers each 110 ft. square. Two Dorrco Flash Mixers were also installed as well as additional filter capacity.

If you'd like more information on the complete line of Dorr water treatment equipment, write for Bulletin No. 9141 to The Dorr Company, Stamford, Connecticut, or in Canada, 26 St. Clair Avenue E., Toronto 5.

Every day, nearly 8 billion gallons of water are treated by Dorr equipment.

FIFTY YEARS 1904-1954

Better tools TODAY to meet tomorrow's demand

DORR

WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

THE DORR COMPANY • ENGINEERS • STAMFORD, CONN.
Offices, Associated Companies or Representatives in principal cities of the world.
DORR EQUIPMENT IS MADE IN CANADA, OF CANADIAN MATERIALS, BY CANADIANS

LEADITE

Jointed for . . . Permanence with LEADITE

Generally speaking, most Water Mains are buried beneath the Earth's surface, to be forgotten,—they are to a large extent, laid for permanency. Not only must the pipe itself be dependable and long lived,—but the joints also must be tight, flexible, and long lived,—else leaky joints are apt to cause the great expense of digging up well-paved streets, beautiful parks and estates, etc.

Thus the "jointing material" used for bell and spigot Water Mains MUST BE GOOD,—MUST BE DEPENDABLE,—and that is just why so many Engineers, Water Works Men and Contractors aim to PLAY ABSOLUTELY SAFE, by specifying and using LEADITE.

Time has proven that LEADITE not only makes a tight durable joint,—but that it improves with age.

The pioneer self-caulking material for c. i. pipe.
Tested and used for over 40 years.
Saves at least 75%

THE LEADITE COMPANY
Girard Trust Co. Bldg. Philadelphia, Pa.

No Caulking